PSNN-2018-0439

■ Safety-related
□ Non-Safety-related
□ ASME CODE
□ Others ( )

Document No.	FPG-PLN-C51-0005	Rev	5

NRW-FPGA-Based PRM System Qualification Project

Document Title Master Test Plan

CUSTOMER NAME	None
PROJECT NAME	NRW-FPGA-Based PRM System Qualification Project
ITEM NAME	PRM Equipment
ITEM NO.	C51
JOB NO.	FPG

TOSHIBA NED verified this Design Document;
Method: Design Review
Verification Report No.: DVR-E2-20180531-1
Verified by T.Ito
Group Name: Second Electrical System Design & Engineering Group
Date June 1, 2018

Rev. No.	Issue Date	Description	Approved by	Reviewed by	Prepared by
5	Jun 1,2018	See DCN-PLN-C51-0005-005	T.Miyazaki Jun 1,2018	T.Miyazaki Jun 1,2018	T. Hayashi Jun. 1, 2018

Initial Issue Date	Issued by	Approved by	Reviewed by	Prepared by	Document Filing No.
Jan.25,2006	Second Electrical System Design &Engineering Group	N.Oda	N.Oda	Y.Goto	RS-5119290

Rev No.	Date	History	Approved by	Reviewed by	Prepared by
0	Jan.25,2006	The first issue	N.Oda	N.Oda	Y.Goto
1	May.25,2006	Revision	N.Oda	T.Ito	Y.Goto
2	Jul 27, 2007	Revision	N.Oda	T.Ito	T.Miyazaki
3	Apr 16,2008	Revision	N.Oda	T.Ito	H.Sakai
4	May 31,2016	Revision	N.Oda	N.Oda	T.Miyazaki
5	See cover page	See cover page	See cover page	See cover page	See cover page

Table of Contents

1. Introduction

Master Test Plan Revision 4 incorporates following:

- Correction of Figure 4-1 for consistency with actual test flow
- Correction of the table in APPENDIX 4 to clarify that the achievable amplitude of OBE and SSE will be identified during the seismic testing and reported in the test report.
- Correction of reference errors

Master Test Plan Revision 5 incorporates following:

- Correction of test frequencies of CE101 and RE102 to be consistent with other documents
- Correction of test levels of Surge Withstand Capability Test and EFT/B Test to be consistent with other documents
- Updates of referenced document revisions

1.1. Background

Toshiba Nuclear Energy System & Service Division (NED) is performing a generic qualification of Non Re-writable Field Programmable Gate Array (NRW-FPGA) technology for safety-related Instrumentation and Control (I&C) systems. These systems mainly operate on the specified digital circuits and have neither central processing units (CPUs) nor operating systems. These systems have high testability and long life. Toshiba is qualifying the NRW-FPGA-based I&C systems for use in safety-related systems at nuclear power plants in the U.S.A.

The specific system to be qualified in this project is the BWR-5 Power Range Monitor (PRM). The PRM system monitors reactor power by measuring neutron flux level, and issues a trip signal when the power exceeds specified set points. The PRM can be used in safety-related (class 1E) systems. Figure 1-1 shows the overview of this project, which comes from Figure 9-1 of the Qualification Plan (Reference (5)).

The qualification of NRW-FPGA-Based PRM System is performed in compliance with EPRI TR-107330 (Reference (1)). The generic qualification approach described in EPRI TR-107330 includes both hardware qualification and software qualification. The EPRI TR-107330 specification requires testing to be performed as part of the

qualification process. This Master Test Plan (MTP) documents Toshiba's plan for performing the required qualification testing. The MTP includes a description of the required testing, a description of the Test System and Equipment, requirements for test procedures, and requirements for documentation of test results.

In addition to EPRI TR-107330, the following documents provide additional background information pertaining to this project:

- Equipment Requirement Specification (ERS) (Reference (4))
- Project QA Manual (PQAM) (Reference (2))
- Preliminary Technical Evaluation Report (PTER) (Reference (7))

The ERS defines functional requirements for NRW-FPGA-Based PRM units (and cable connecting the units), design conditions and applicable codes and standards. The ERS also specifies requirements and conditions necessary to be qualified. Major design input documents for establishing the ERS are the PRM System Design Specification for Japanese Plants, EPRI TR-107330 and the vendor package specifying the commercial products by Fuchu Complex.

> *NOTE: The goal of Toshiba's SER project is to meet all applicable requirements from EPRI TR-107330. These requirements are summarized in the Equipment Requirement Specification (Reference 4). Accordingly, this Master Test Plan summarizes how the applicable ERS requirements (taken from EPRI TR-107330) are satisfied in this project. See Appendix A of this Master Test Plan for a description of how the ERS are satisfied in this test plan. See the ERS for a description of how the applicable EPRI TR-107330 requirements are satisfied in the ERS.*

The Qualification Plan identifies the approach for qualification and acceptance for the commercial grade items, including the required qualification activities including testing, and the required procurement and acceptance activities. The Qualification Plan shows that the Test Specimens and Test Equipment with associated services will be procured using commercial grade dedication. Toshiba will perform the dedication activities, and other qualification testing activities, in accordance with PSNE 10CFR50 Appendix B

compliant quality assurance program.

The PTER is to describe results of the preliminary technical evaluation to ensure that the NRW-FPGA-Based PRM System meets all safety design and quality requirements for US nuclear plant applications as one of major activities for commercial grade dedication. The preliminary technical evaluation includes identification of the requirements to be imposed on Fuchu Complex as part of the commercial grade procurement of the Test System, and required qualification activities including qualification testing by NED.

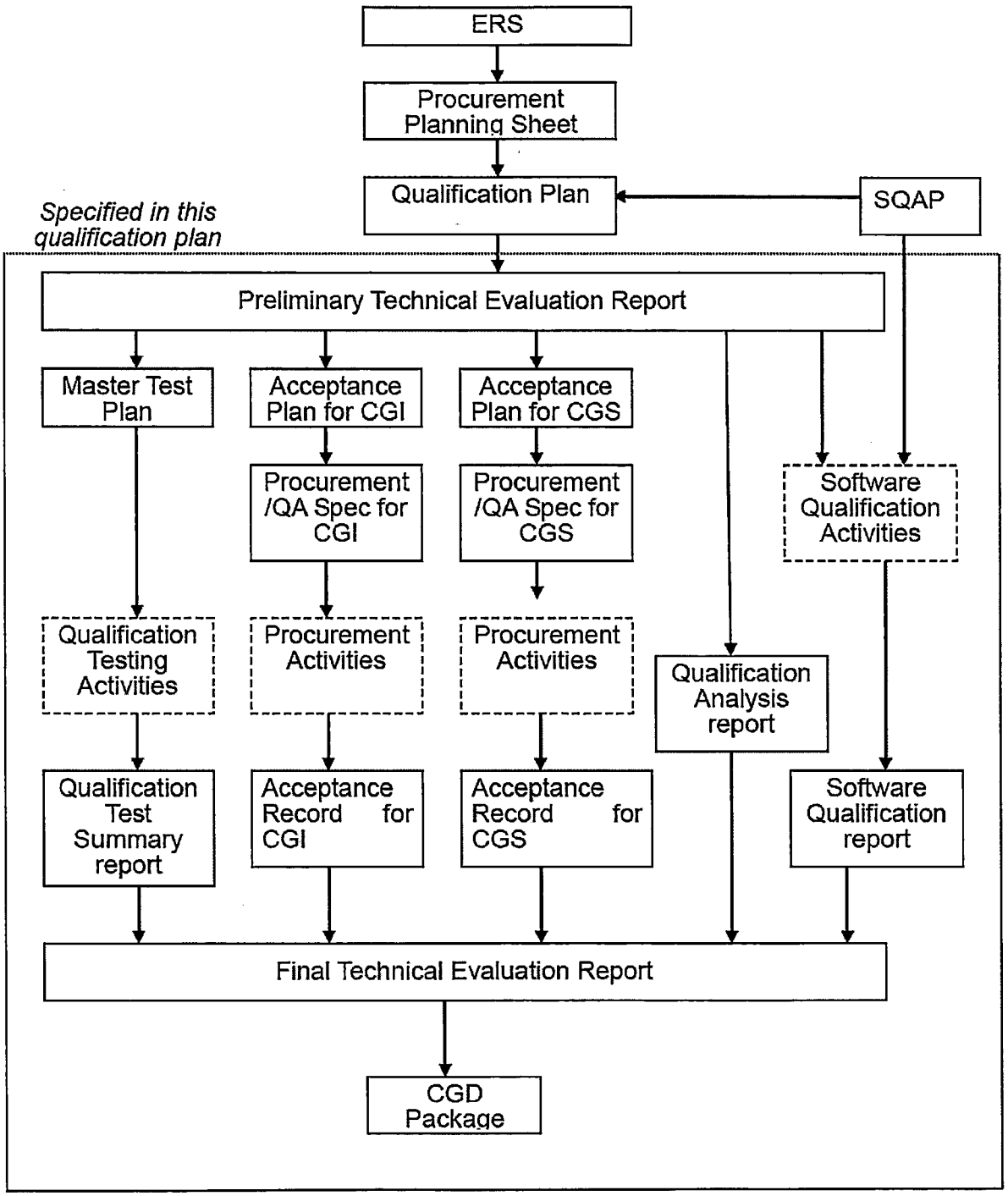

Figure 1-1 Relationship Between Project Documents
(Figure 9-1 of the Qualification Plan)

1.2. Scope of the Master Test Plan

This Master Test Plan (MTP) provides an overview of Toshiba testing program and provides a bridge between the ERS and the test program results. The MTP contents include the following:

- An overview of the overall test program.
- A description of the test procedures, including the procedure for test setup.
- A description of the Test System (Test Specimen and Test Equipment) to be used in these tests.
- Requirements for documenting test results and evaluating results against the acceptance criteria.

The PRM to be qualified in this project differs from PLC-based equipment typically qualified using EPRI TR-107330. Based on the EPRI TR-107330, the ERS specifies equipment requirements of the units to be qualified. The PTER identifies requirements for qualification testing from all ERS requirements. Because the MTP complies with such requirements, in this test plan, test requirements such as the types of tests, and the order of the tests, meet the qualification requirements of EPRI TR-107330 and functional requirements for PRM. Details of the functions that are evaluated are described in Section 3 of this test plan. These tests will demonstrate the suitability of the system to perform with high reliability in a nuclear power plant environment.

1.3. Description of Test Specimen and Test Equipment

The PRM system to be tested in this qualification project shall be designed in accordance with the ERS, which has been established to summarize the applicable requirements from the following three documents:

- EPRI TR-107330,
- PRM System design specification provided for a typical Japanese plant
- Fuchu Complex vendor information

Qualification testing is performed on a Test System, which contains a Test Specimen and Test Equipment. The configuration of the Test System used in this qualification project is shown in Figure 4-1 of the PTER.

More detailed configuration of the Test System is defined by the ECWD, which will be established by Fuchu Complex as a commercial grade service.

- The Test Specimen is composed of all the units needed to create a typical PRM system for a BWR-5. The Test Specimen for the project consists of one LPRM Unit, one LPRM/APRM Unit, and one Flow Unit, and the interconnecting cables and the spare modules and the spare chassis that are used for the maintenance of the Test Specimen. Appendix 1 provides a detailed description of the Test Specimen. Detailed configuration information such as serial numbers, logic versions, etc. shall be provided in a Master Configuration List (MCL) (Reference (6)).

- The Test Equipment is composed of the equipment needed to generate the input signals and to monitor the output signals of the Test Specimen during the qualification testing. As described in Section 6.3 of this MTP, this includes data recorder, variable power supply, input simulators, etc. The Test Equipment shall be provided and controlled based on the ERS section 7.3.1.3 that is established to satisfy the requirements of EPRI TR-107330 section 6.2.3. The PTER specifies Test Equipment requirements. Test Equipment shall be provided as a commercial grade service, and shall be controlled as stated in the PTER. Detailed Test Equipment specifications are described in MTP Section 6.3.

2. References, Definitions and Acronyms

2.1. References

(1) EPRI TR-107330
Generic Requirements Specification for Qualifying a Commercially Available PLC

for Safety-Related Applications in Nuclear Power Plants, Final Report dated December 1996.

(2) FPG-PLN-A70-0001
NRW-FPGA-Based PRM System Qualification Project Project Quality Assurance Manual

(3) FPG-PLN-C51-0002
NRW-FPGA-Based PRM System Qualification Project Software Quality Assurance Plan

(4) FPG-RQS-C51-0001
NRW-FPGA-Based PRM System Qualification Project Equipment Requirement Specification of FPGA based Units

(5) FPG-PLN-C51-0003
NRW-FPGA-Based PRM System Qualification Project Qualification Plan

(6) FPG-CFM-C51-0001
NRW-FPGA-Based PRM System Qualification Project Master Configuration List

(7) FPG-DRT-C51-0002
NRW-FPGA-Based PRM System Qualification Project Preliminary Technical Evaluation Report

(8) AS-200A015
Design Change Control Procedure

(9) AS-300A103
Test Control Procedure

(10) AS-300A007
Procedure for Acceptance of the Items and Services

(11) AS-300A008
Nonconformance Control and Corrective Action Procedure

(12) AS-300A102
Qualification Procedure of Test Personnel and Witness Inspector for Instrumentation and Electrical Items and Services

(13) AS-100A004
Document Control Procedure

(14) AS-500A007
General Requirements for Handling, Storage, Cleaning, Packaging, Shipping and Preservation

(15) MIL-STD-461E

Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

(16) FPG-VDN-C51-0200

Radiation Exposure, Environmental, and Seismic Qualification Test Procedure for a Toshiba FPGA-based PRM System

(17) FPG-VDN-C51-0201

EMI MIL-STD-461E Test Procedure on a new-FPGA-Based PRM System

2.2. Definitions and Acronyms

Test System, Test Specimen, and Test Equipment. The Qualification Project performs qualification of PRM Units installed in a Test System. Terms relating to the Test System are defined as follows:

- Test System means a system consisting of Test Specimen and Test Equipment.
- Test Specimen means NRW-FPGA-Based I&C Units, and the cable between the Units, to be tested for hardware qualification.
- Test Equipment means support equipment for the qualification test of the Test Specimen such as the simulator, cable, and data logger.

APRM:	Average Power Range Monitor
CDR:	Critical Digital Review
CGD:	Commercial Grade Dedication
CGI:	Commercial Grade Item
CTM:	Compliance and Traceability Matrix
ECWD:	Electrical Cable Wiring Diagram
EFT/B:	Electrically Fast Transients and Burst
ERS:	Equipment Requirement Specification
ESD:	Electro Static Discharge
FPGA:	Field Programmable Gate Array (a programmable logic device).
I&C:	Instrumentation and Control
LPRM:	Local Power Range Monitor
MCL:	Master Configuration List
MTP:	Master Test Plan

NED:	Nuclear Energy Systems & Services Division
NICSD:	Nuclear Instrumentation & Control Systems Department
NNR:	Nonconformance Notice Report
NRW-FPGA	Non-Rewritable FPGA
OBE:	Operating Basis Earthquake
OPRM:	Oscillation Power Range Monitor
PLC:	Programmable Logic Controller
PQA:	Project Quality Assurance
PQAM:	Project QA Manual
PRM:	Power Range Monitor
PTER:	Preliminary Technical Evaluation Report
QA:	Quality Assurance
QC:	Quality Control
RTM:	Requirement Traceability Matrix
SER:	Safety Evaluation Report
SQAP:	Software QA Plan
SS:	System Design Specification
SSE:	Safe Shutdown Earthquake
V&V:	Verification and Validation

3. Safety Functions to be Demonstrated

3.1. Safety Functions under Normal Conditions

The safety functions to be demonstrated in the qualification testing are the capability to perform to the following requirements specified in the ERS section 4.1.2 under normal conditions.

1. Generate signals that represent:
   a. Local thermal neutron flux (Local Power Range Monitor (LPRM) level)
   b. Spatially averaged neutron flux (Average Power Range Monitor (APRM) level)

c. Spatially averaged heat flux (simulated thermal power signal)
d. Recirculation flow

2. Provide the following trips to the Reactor Protection System (RPS) - Divisional APRM trips shall be initiated by any of the following:
   a. APRM Upscale (High-High)
   b. APRM Thermal Power Upscale
   c. APRM Inoperative

3.2. Safety Functions under Stressed Conditions

The safety functions to be demonstrated in the qualification testing are the capability to perform the functions specified in the ERS section 4.1.2 under stressed conditions as defined in the ERS section 5.5, including the ability to:

- function after exposure to radiation,
- function during and after abnormal temperature and humidity conditions,
- function after exposure to operating basis and design basis seismic events,
- function during exposure to EMI/RFI conditions,
- function during exposure to voltage surges,
- function during exposure to EFT/B conditions,
- function during exposure to ESD conditions,
- demonstrate Class 1E to Non 1E electrical isolation capability of selected modules.
- function under varying input power quality (voltage and frequency) conditions.

Acceptance criteria for the qualification tests are specified in the ERS section 7.2.2, 7.2.3, 7.2.4 and 7.3.

4. Qualification Test Description

4.1. Basis for Test Requirements

Qualification test requirements are provided in Sections 5 and 6 of EPRI TR-107330. This specification provides generic testing requirements. Based on the generic testing requirements, Toshiba NED specifies specific testing requirements for the project in the ERS chapter 7. For those EPRI test requirements that are not applicable to the FGPA-based Test System qualified in this project, Toshiba NED identifies these as application specific requirements or exceptions to the EPRI requirements. Appendix A of the MTP shows the cross reference between ERS requirements and the MTP section.

4.2. Description of Required Tests

Initial Testing will be performed for the assembled Test System in Japan, and then the Test Specimen and some of the Test Equipment will be shipped to the United States of America for testing at the[ ]^{a,c} The testing to be performed is as follows:

- Pre-Qualification Test, conducted prior to qualification testing to determine that the system operates correctly and to provide baseline data on equipment performance. These tests are performed at Toshiba, and at the[ ]^{a,c}test facility. Pre-Qualification Tests include:

    - System Set-up and Check-out Test at Fuchu Complex.
    - Burn-in test at Fuchu Complex.
    - System Set-up and Check-out Test (after shipping and re-assembly at [ ]^{a,c}.
    - Operability Test
    - Prudency Test

- Qualification Tests, conducted to demonstrate compliance with ERS requirements, and to demonstrate suitability of equipment while subject to stress conditions.

Qualification Tests will all be performed at [ ]^{a,c} on the assembled Test System after the system has passed the Pre-Qualification Testing acceptance criteria. The Qualification Tests include:

- System Set-up and Check-out Test (as needed following system disassembly/reassembly, or relocation of Test System)
- Environmental Test (Radiation and Temperature/Humidity Exposure; including Operability and Prudency Tests)
- Seismic Test (Resonance Search plus Tri-Axial Seismic Withstand Capability; including post-seismic operability check)
- EMI/RFI Test
- Surge Withstand Capability Test
- EFT/B Test
- ESD Test
- Class 1E/Non-1E Electrical Isolation Test
- Power quality Test (to be performed during other tests)

- Performance Proof Tests, conducted to confirm satisfactory operation after being subjected to qualification test conditions. Performance Proof Tests are merely a repeat of selected pre-qualification baseline tests to identify any changes in equipment performance. So the Test System is re-configured to evaluate the aging effect mainly by Environmental and Seismic Tests.

  Performance Proof Tests will be performed at [ ]^{a,c} and include:

  - System Set-up and Check-out Test
  - Operability Test (retest)
  - Prudency Test (retest)

The sequence of tests is shown in Table 4-1 and Figure 4-1 below.
As shown in the flow diagram in Figure 4-1, the LPRM module HNS011, AO modules HNS511, HNS512, HNS513, and HNS514 are replaced with LPRM module HNS013, AO modules HNS515, HNS516, HNS517 and HNS517 during EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation tests. After the EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests, the replaced modules are removed and the original modules are re-installed to

evaluate the aging effect during Environmental Test.

Note: Many System Set-up and Check-out Tests are performed as the part of the other testing.

The Toshiba Qualification Test Procedures for the Environmental (FPG-TPRC-C51-1002), Seismic (FPG-TPRC-C51-1003), and EMI/RFI (FPG-TPRC-C51-1004) Testing encompass the Operability and Prudency Testing required by ERS section 7.2.2 and 7.2.3.

Table 4-1. Qualification Testing Overview

Test		ERS Ref. Para.	Toshiba Test Procedure Number	[ ]ac Test Procedure Number	Test Plan
1.Pre-Qualification Test	1.1 System Set-up and Check-out Test	Not applicable	FPG-TPRC-C 51-0001	Not applicable	App. 2 Pre-Qualification Test Plan
	1.2 Burn-in Test	7.2.1 B		Not applicable	
	1.3 System Set-up and Check-out Test	Not applicable	FPG-TPRC-C 51-1001	Not applicable	
	1.4 Operability Test	7.2.2, 7.2.4	FPG-TPRC-C 51-1009	Not applicable	
	1.5 Prudency Test	7.2.3, 7.2.4	FPG-TPRC-C 51-1010	Not applicable	
2. Qualification Test	2.2 Environmental Test (Radiation Exposure)	7.3.2.4, 5.5.1	FPG-TPRC-C 51-1002	FPG-VDN-C51-0200	App. 3 Environmental Test Plan
	2.4 Environmental Test (Temperature and Humidity)	7.3.2.4, 5.5.1	FPG-TPRC-C 51-1002	FPG-VDN-C51-0200	
	2.6 Seismic Test	7.3.2.5, 5.5.2	FPG-TPRC-C 51-1003	FPG-VDN-C51-0200	App. 4 Seismic Test Plan
	2.8 EMI/RFI Test	7.3.2.2, 5.5.3	FPG-TPRC-C 51-1004	FPG-VDN-C51-0201	App. 5 EMI/RFI Test Plan
	2.9 Surge Withstand Capability Test	7.3.2.7, 5.5.4	FPG-TPRC-C51-1005	FPG-VDN-C51-0201	App. 6 Surge Withstand Capability Test Plan

Test		ERS Ref. Para.	Toshiba Test Procedure Number	Wyle Test Procedure Number	Test Plan
	2.10 EFT / B Test	7.3.2.9, 5.5.5	FPG-TPRC-C51-1006	FPG-VDN-C51-0201	App. 7 EFT / B Test Plan
	2.11 ESD Test	7.3.2.10, 5.5.6	FPG-TPRC - C51-1007	FPG-VDN-C51-0201	App. 8 ESD Test Plan
	2.12 Class 1E to Non-1E Isolation Test	7.3.2.8, 5.5.7	FPG-TPRC - C51-1008	FPG-VDN-C51-0201	App. 9 Class 1E to Non-1E Isolation Test Plan
3. Performance Proof Test	3.2 Operability Test	7.2.2, 7.2.4	FPG-TPRC-C 51-1009	Not applicable	App. 10 Performance Proof Test Plan
	3.3 Prudency Test	7.2.3, 7.2.4	FPG-TPRC - C51-1010	Not applicable	

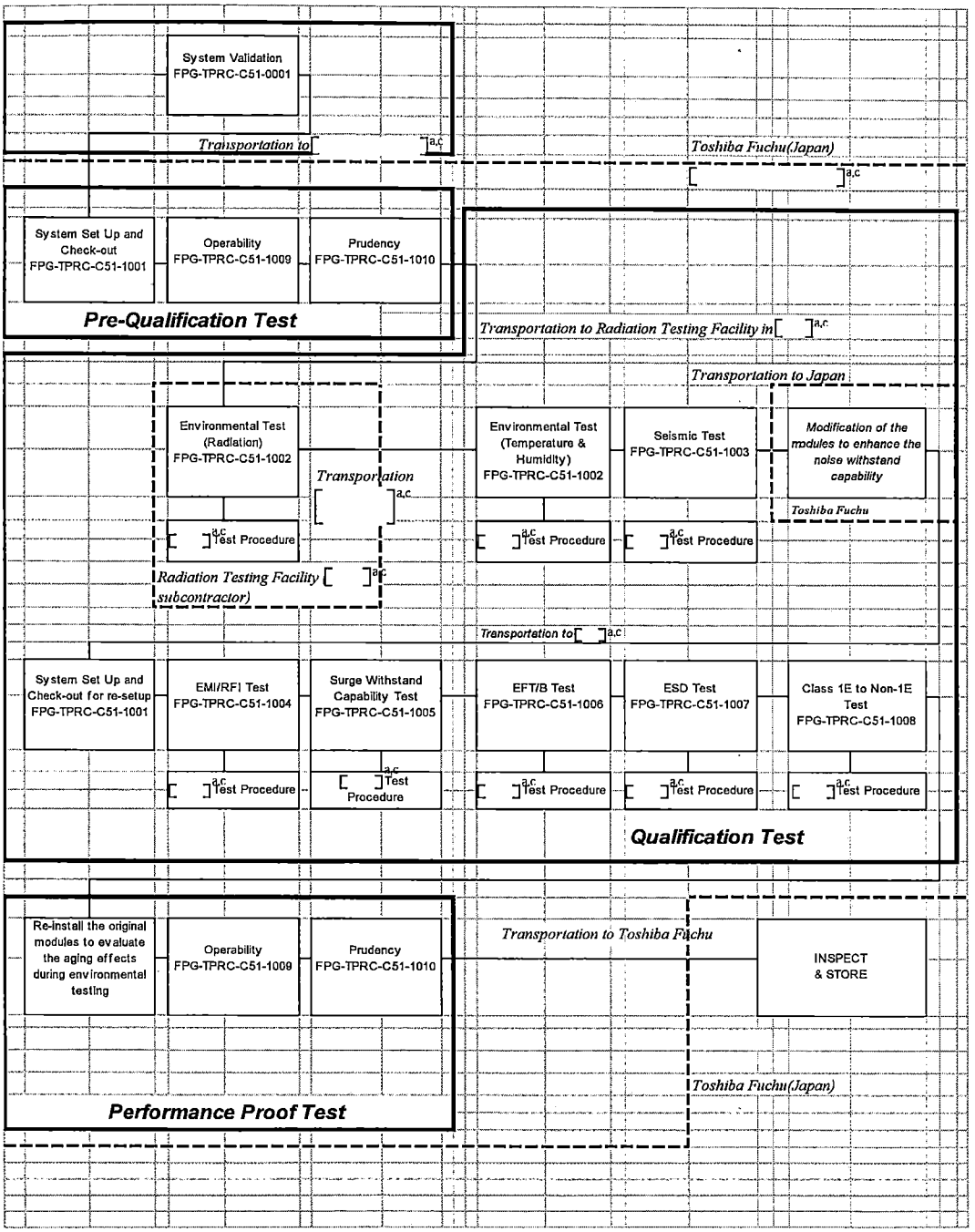

Figure 4-1. Master Test Plan Flow Diagram

5. Test Plans

Test Plans provide a link between the test requirements of the ERS and the test procedures. Test Plans address general testing approach, objectives, reference to requirements, general testing criteria, service conditions, environmental conditions, sequence of tests, and applicable procedures. Test Plans have been prepared for various tests or testing categories (Environmental, Seismic, etc.), as listed in appendices 2 to 10:

Appendix 2, Pre-Qualification Test Plan
Appendix 3, Environmental Test Plan
Appendix 4, Seismic Test Plan
Appendix 5, EMI/RFI Test Plan
Appendix 6, Surge Withstand Capability Test Plan
Appendix 7, EFT/B Test Plan
Appendix 8, ESD Test Plan
Appendix 9, Class 1E to Non-1E Isolation Test Plan
Appendix 10, Performance Proof Test Plan

6. Test Program Implementation

6.1. Methodology

During the Pre-Qualification Testing phase, equipment acceptance testing is performed to confirm that the Test Specimen operates correctly, to document initial FPGA calibration, and to obtain baseline performance data on the equipment. Baseline performance data is obtained through performance of the Operability and Prudency Tests.

During the qualification testing phase, the Test Specimen will be subject to simulated environmental stresses such as temperature, humidity, seismic conditions, EMI, etc. During the test conditions, the standard logic to implement power range neutron monitoring will be running in the Test Specimen to exercise all modules and provide the

application logic for the Test Specimen. Simulated inputs and dummy loads on outputs will be applied to provide a simulation of actual field applications. To verify that the equipment is properly functioning under the stressed environmental conditions, outputs will be continuously monitored to confirm expected responses to simulated inputs, which will also be continuously monitored.

During the Performance Proof Test phase, the Operability and Prudency Tests will be repeated and the results compared to the baseline performance data.

All testing shall be performed in accordance with written test procedures. Test procedures control the detailed sequence of testing activities and document the results. The procedures define equipment set-up, environmental conditions, specific testing steps, performance data collection requirements, verifications, and measuring equipment used. The test procedures to be used are maintained in the Project Controlled Documents List (PCDL) in accordance with the Document Control Procedure (AS-100A004 (Reference (13))). Test procedures will be prepared, reviewed and approved in accordance with the Test Control Procedure (AS-300A103 (Reference (9))).

For certain tests, hold points may be required for Level II or Level III test personnel (as defined in Qualification Procedure of Test Personnel and Witness Inspector for Instrumentation and Electrical Items and Services AS-300A102(Reference (12))) to evaluate the validity and acceptability of testing results at intermediate points in the testing. These hold points shall be required when necessary to prevent proceeding with testing if unexpected conditions have occurred. Hold points shall be defined in the applicable test procedures.

6.2. Test Personnel

NED test personnel and [ ]^{a,c} personnel will perform the qualification testing. Each NED test person performing test activities shall meet the requirements of Qualification Procedure of Test Personnel and Witness Inspector for Instrumentation and Electrical Items and Services (AS-300A102), Level I as a minimum. Test results shall be evaluated by an NED test person who (1) meets the requirements of AS-300A102 Level

II as a minimum, and (2) did not perform the testing being evaluated.

Contractors' ([ ]^{a,c} subcontractor) personnel participating in qualification testing will be approved by Toshiba in accordance with vendor control requirements specified in the PQAM (Reference (2)) section 4.8.

6.3. Test Equipment

Testing activities will be conducted using Test Equipment. The Test Equipment, for which equipment requirements are specified in the PTER section 4.3.4, includes the following components:

- Trip Auxiliary Unit
  The Trip Auxiliary Unit shall contain relays. The relays isolate the Test Specimen DIO modules from surge events external to the relay. One relay is needed for each input and output of each DIO module in the Test Specimen. During qualification tests, the output voltage from the relays is recorded on the data recorder.
  Trip Auxiliary Unit will be designed and fabricated by Fuchu Complex as a commercial grade service.
- Test Equipment FLOW Unit
  One FLOW Unit is included in the Test Specimen. In addition, one additional FLOW Unit is required for the Test Equipment. The Test Equipment FLOW Unit is used to provide a flow signal from the other division of the PRM system.
  Test Equipment FLOW Unit will be designed and fabricated by Fuchu Complex with Test Specimen Units.
- DI/DO Simulator
  Digital inputs to the Test Specimen are generated using a DI/DO simulator. Outputs from this simulator are supplied to the Trip Auxiliary Unit. Outputs of the corresponding Trip Auxiliary Unit relays will be supplied to DI modules installed in the Test Specimen. Digital outputs of the Test Specimen are displayed to test personnel using a DI/DO simulator. This simulator includes lamps that indicate the DO status (engaged / not engaged). Inputs to the DO simulator come

from the Trip Auxiliary Unit.

In the DI/DO simulator, a control relay is included. The control relay is used to provide capability for periodical status change of DIs needed for Prudency Testing.

The DI/DO Simulator will be designed and fabricated by Fuchu Complex as a commercial grade service.

- LPRM/FLOW Signal Simulator

  Simulated input current signals for the LPRM modules and the SQ-ROOT modules shall be provided by one or more LPRM/FLOW signal simulators. The signal output capability shall be sufficient for all modules installed in the Test Specimen.

  The LPRM/FLOW Signal Simulator will be designed and fabricated by Fuchu Complex as a commercial grade service.

- Current Monitor Box (Current Voltage Conversion Box)

  A current monitor box shall be provided to monitor the current signals fed to the LPRM modules and the SQ-ROOT modules.

  Current Monitor Box will be designed and fabricated by Fuchu Complex as a commercial grade service.

- Variable power supply (AC Power Supply)

  An AC/AC Converter shall be used for the power supply for the Test Specimen. This AC/AC Converter shall have a sufficient capability to perform the power tolerance testing to be done in the qualification testing.

- Data Recorder

  The data recorder is used to record the following data during tests:

  - All analog outputs from the Test Specimen.
  - All analog inputs to the Test Specimen.
  - All digital outputs from the Trip Auxiliary Unit
  - All digital inputs to the Trip Auxiliary Unit
  - Analog output from the FLOW Unit which is provided as a Test Equipment

  These data shall be continuously recorded during the periods when the Test Specimen is operating during qualification testing.

  The transient input/output signals for the Test Specimen shall be monitored to verify the response time characteristics only for the duration needed to confirm the response of the Test Specimen.

- Rack
  The entire Test Specimen, and the Trip Auxiliary Unit, shall be installed in a rack during all qualification testing except the Seismic Testing.
  Rack will be designed and fabricated by Fuchu Complex as a commercial grade service.
- Cable external to the Test Specimen
  All cables shall be fabricated in accordance with the ECWD (Electrical Cable Wiring Diagram).
  Cables will be designed and fabricated by Fuchu Complex as a commercial grade service.

The Test Equipment involved in this qualification test program is supplied for testing purposes only and may be considered as commercial grade. The Test Equipment will not be qualified with the Test Specimen. The ECWD describes Test Equipment setup configuration. Operation of the Test Equipment shall be defined in each test procedure and shall be in accordance with the Test Equipment user manual.

Test Equipment shall be controlled in accordance with the PQAM section 14.

6.4. Measuring and Test Equipment Calibration

As described in PTER section 4.3.1.2, the Test System data recorder shall record all input signals to, and output signals from the Test Specimen. This requirement ensures that all inputs and outputs are recorded using calibrated equipment. This relieves the requirements for accuracy and calibration of signal generating equipment.

Measuring and Test Equipment affecting qualification of safety-related functions shall be calibrated during testing at Fuchu Complex by NED and at[ ]^{a,c}
The equipment to be calibrated is as follows:

- Current Monitor Box
- Variable power supply
- Data Recorder

The Current Monitor Box is a specially designed piece of equipment for the testing and shall be provided by Fuchu Complex as a commercial grade service. Therefore, the Current Monitor Box is shipped from Fuchu Complex to [ ]^{a,c}. The shipment should be performed in accordance with General Requirements for Handling, Storage, Cleaning, Packaging, Shipping and Preservation (AS-500A007 (Reference (14))).

On the other hand, the variable power supply and data recorder are standard Test Equipment. Therefore, NED plans to rent the variable power supply and data recorder Test Equipment. NED may rent this equipment from supplier(s) in Japan, and use different supplier(s) for the [ ]^{a,c} testing. Calibration records shall be obtained and retained for these equipment components.

6.5. Testing Quality Assurance

Testing specified in the ERS section 7.2 and 7.3 shall be performed and documented in accordance with the requirements of 10CFR50, Appendix B. Therefore, these tests are performed by NED itself under the PSNE 10CFR50 Appendix B QA Program.

Personnel performing the tests shall be qualified as described in Section 6.2 of this MTP.

Personnel reviewing the test results, and personnel approving the test report shall be the QC engineers whose skills are approved by NED PQA group.

All related documents shall be controlled in accordance with Document Control Procedure (AS-100A004).

Test data records should include appropriate columns spaces for the signature or initials of the tester and reviewer for each hold points determined as shown in section 6.1.

6.6. Responsibilities

The responsibilities for the preparation, installation, operation, monitoring, and recording of equipment during the qualification test (performed at the Test Facility) are described in this Section. The responsibilities are summarized in Table 6-1.
Tests are performed by the engineers and specialists authorized by Toshiba or the test facilities. In this plan the test facility will be [ ]^{a,c} The activities performed by the test facility's personnel are approved by Toshiba.

Table 6-1 Responsibilities for Qualification Testing

Section	Items		Responsibilities	
			Toshiba	Test Facility
6.6.1.1	Preparation	Power source	-	responsible
6.6.1.2		Signal cables and equipment for data recording for PRM	responsible	-
6.6.1.3		Environmental Test Equipment	-	responsible
6.6.1.4		Seismic Test Equipment	-	responsible
6.6.1.5		Cables and equipment for data recording for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests	-	responsible
6.6.2.1	Installation	Placement	-	responsible
6.6.2.2 (1)		Connection of the cables for environmental monitoring and data recording	-	responsible
6.6.2.2 (2)		Connection of the cables between PRM and EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Test Equipment.	-	responsible

Section	Items		Responsibilities	
			Toshiba	Test Facility
6.6.2.2 (3)		Connection of the cables for PRM except for the connection to the[ ]a,f Test Equipment.	responsible	-
6.6.3.1	Operation	PRM	responsible	-
6.6.3.2		Equipment for Environmental Test	-	responsible
6.6.3.3		Equipment for Seismic Tests	-	responsible
6.6.3.4		Equipment for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests	-	responsible
6.6.4.1	Monitoring /Recording	Environmental Conditions	-	responsible
6.6.4.2		Data recording of PRM	responsible	-
6.6.4.3		Equipment for Environmental, Seismic, EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests	-	responsible

6.6.1. Preparation

6.6.1.1 Preparation of Power Connection

[ ]a,c is responsible for the preparation of the AC power source for all tests. The variable voltage power supply used for the all tests is prepared by Toshiba.
Requirements for the power source in the test activities are as follows:

(1) 200VAC(200-240VAC), 60Hz, 20A for Test Specimens
(2) 100VAC, 60Hz, 20A for Test Equipment

6.6.1.2 Preparation of Signal Cables and Equipment for Data Recording for PRM

Toshiba is responsible for the preparation for the signal cables and equipment for data recording for PRM. However[ ]a,c is responsible for the preparation of the cable,

and the equipment for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests.
Cable connections for the equipment are shown in ECWD.

6.6.1.3 Preparation of Environmental Test Equipment

[ ]a,c is responsible for the preparation of the Test Equipment such as environmental chamber and sensors such as thermometers and hygrometers for the Environmental test. [ ]a,c also provides the traceability data of the equipment used in these tests to monitor the application level in each test, which shall be traceable to the test standard referred to in each test.

6.6.1.4 Preparation of Seismic Test Equipment

[ ]a,c is responsible for the preparation of the Test Equipment such as the vibration Test Equipment and the accelerometers for the Seismic Test. [ ]a,c also provides the traceability data of the equipment used in these tests to monitor the application level in each test, which shall be traceable to the test standard referred to in each test.

6.6.1.5 Preparation of Cables and Equipment for Data Recording for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests

[ ]a,c is responsible for the preparation of the cables and the equipment for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests such as coupling/decoupling network, capacitive clamp, antenna or oscilloscope. [ ]a,c also provides the traceability data of the equipment used in these tests to monitor the application level in each test, which shall be traceable to the test standard referred to in each test.

6.6.2. Installation

6.6.2.1 Placement

[ ]a,c is responsible for the movement of the all apparatus to the adapted position in each test. Mounting requirements for each test are described in each test plan (see the Appendices to this Master Test Plan).

6.6.2.2 Connection

(1) [ ]a,c is responsible for the connection of the cables for monitoring and data recording equipment for Environmental and Seismic Tests, such as thermometers, hygrometers and accelerometers.

(2) [ ]a,c is responsible for the connection of the cables between PRM and EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Test Equipment.

(3) Toshiba is responsible for the connection of the cables for PRM except for (1) and (2).

The Cable connections for the equipment are shown in the Schematic Diagrams for PRM.

6.6.3. Operation

6.6.3.1 Operation of Test System

Toshiba is responsible for operation of Test System such as changing the parameter inputs or switch position.

6.6.3.2 Operation of Equipment for Environmental Test

[ ]a,c is responsible for the operation of the environmental test chamber equipment such

as temperature control and humidity control equipment.

6.6.3.3 Operation of Equipment for Seismic Test

[ ]^{a,c} is responsible for the operation of the equipment for Seismic Tests such as vibration control.

6.6.3.4 Operation of Equipment for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests

[ ]^{a,c} is responsible for the operation of the equipment for EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Tests such as applying surge or test pulse.

6.6.4. Monitoring and Recording

The test records obtained by [ ]^{a,c} personnel and the test records obtained by the Toshiba personnel in the same test shall be made available to each company. The document numbers of both sets of records shall be cited in each set of records.

6.6.4.1 Monitoring of Environmental Conditions

[ ]^{a,c} is responsible for the monitoring of the environmental conditions such as temperature or relative humidity indicated in the test procedure.

6.6.4.2 Data recording of PRM

Toshiba is responsible for the data recording of the PRM.

6.6.4.3 Data recording of Equipment for Environmental, Seismic, EMI/RFI, Surge Withstand Capability, EFT/BT, ESD and Class 1E to Non-1E Isolation Tests

[ ]^{a,c} is responsible for the data recording of the equipment for Environmental, Seismic, EMI/RFI, Surge Withstand Capability, EFT/BT, ESD and Class 1E to Non-1E Isolation Tests. The data to be recorded in each test is as follows:

(1) For Environmental Tests: Setting value of temperature, relative humidity, date and time, Measurement value of temperature, relative humidity, date and time, and monitoring point.
(2) For Seismic Test: level of vibration, response spectrum of vibration, application start/stop time.
(3) For EMI/RFI, Surge Withstand Capability, EFT/B, ESD and Class 1E to Non-1E Isolation Test: Application level, envelope, signal wave, measured level, application or measurement condition, position, start and stop time.

6.6.5. Test Procedures

The test procedures control the detailed sequence of testing activities. The test procedures define applicable test set-up, environmental conditions, and each testing specifications.
Toshiba and [ ]^{a,c} make test procedures as specified in Table 4-1 prior to all tests.
[ ]^{a,c} makes the following test procedures:

(1) Environmental Test Procedure
(2) Seismic Test Procedure
(3) EMI/RFI Test Procedure
(4) Surge Withstand Capability Test Procedure
(5) EFT/B Test Procedure
(6) ESD Test Procedure
(7) Class 1E to Non-1E Isolation Test Procedure

[ ]^{a,c} establishes its test procedures based on:

- Toshiba's test procedures
- The responsibilities shown in Section 6.6
- The test conditions shown in Appendices 3 through 9

These test procedures are reviewed and approved by Toshiba prior to testing.

7. Aging Conditioning

As specified in the ERS Section 7.3.2.1, the Environmental Testing is performed first to age the equipment condition prior to the other qualification tests. After Environmental Testing, the other tests may be performed in any order.

Accordingly, the test sequence for qualification tests in this MTP places the Environmental Tests ahead of all other qualification tests. See Section 4.2 for the test sequence.

Note that during certain test activities, such as isolation testing, may result in damage or destruction of components in the Test Specimen. Accordingly, Toshiba shall provide replacement components to be installed if needed.

8. Maintenance/Modifications during Testing

Maintenance conducted during testing will be performed by [ ]^{a,c} qualified personnel in accordance with Toshiba's procurement specification for [ ]^{a,c} testing services. System configuration shall be verified prior to each test as part of the test procedure. Configuration verification, maintenance and/or configuration change activities shall be performed only by personnel qualified to Level II capabilities in accordance with the Qualification Procedure of Inspection and Test Personnel and Witness Inspector for Instrumentation and Electrical Items and Services (AS-300A102 (Reference (12))).

Details of these verification, maintenance and/or configuration change activities shall be documented by Toshiba in the applicable test reports. These controls shall be in place throughout the qualification test program to maintain the test validity.

System malfunctions and unanticipated failures in equipment will be documented on Nonconformance Notice Reports (NNRs) in accordance with Nonconformance Control and Corrective Action Procedure (AS-300A008 (Reference (11))) by Toshiba test personnel, and provided to Toshiba PQA personnel for evaluation and disposition. The effect of repairs, replacements, and modifications on testing in progress will be evaluated as part of the NNR disposition. The need to perform retesting will be specifically addressed.

The modifications of Toshiba's Test Specimen and Test Equipment are considered as design changes and will be processed in accordance with Design Change Control Procedure (AS-200A015 (Reference (8))).

Should components in the Test Specimen fail during qualification and require replacement, replacements shall be made using spare components that have been exposed to aging conditions as described in Section 7 of this MTP except EMC tests.

9. Test Deviations/Failures

9.1. Deviations in the qualification tests

Deviations in the qualification tests shall be treated as Nonconformances, and shall be documented on Nonconformance Notice Reports (NNRs) in accordance with Nonconformance Control and Corrective Action Procedure (AS-300A008) by Toshiba test personnel, and provided to Toshiba PQA personnel for evaluation and disposition. Toshiba shall document any test deviations in the test report.

9.2. Threshold measurement during EMC susceptibility tests

Detailed threshold testing and analyzed test results as shown in MIL-STD-461E (Reference (15)) will not be necessary. They are not effective in EMC susceptibility tests.
So susceptibility frequency bands are divided into large regions. Toshiba and [ ]^{a,c} find the level of acceptable operation for each region, rather than find the level of acceptable operation for each discrete susceptible frequency within the region.

10. Other Considerations

10.1 Transportation to [ ]^{a,c}

Qualification Test activities consist of testing at Fuchu Complex and [ ]^{a,c} After the testing at Fuchu Complex, the Test Specimen with some Test Equipment shall be shipped to [ ]^{a,c} The packaging and shipping shall be performed in accordance with the ERS section 8.1 and 8.2. At [ ]^{a,c} Toshiba NED shall receive the Test Specimen and Test Equipment for acceptance of shipping service in accordance with Procedure for Acceptance of the Items and Services (AS-300A007 (Reference (10))).

The radiation testing will be performed in a separate facility outside of Huntsville. [ ]^{a,c} will perform the required shipping between Huntsville and the outside radiation test laboratory in accordance with [ ]^{a,c} 10CFR50 Appendix B compliant quality assurance program. Toshiba will audit [ ]^{a,c} shipping procedures as part of the procurement activities for test services from [ ]^{a,c}

After qualification testing, the Test Specimen with some Test Equipment shall be shipped to Fuchu Complex and stored until issuance of the SER by NRC. The packaging and shipment also should be performed in accordance with the ERS section 8.1 and 8.2, and stored in accordance with storage requirement to be provided with the Test Specimen by Fuchu Complex.

10.2 Applicability of EPRI TR-107330 Section 6.2.2, "Test Specimen Application Program Configuration Requirements."

EPRI TR-107330 defines a Test Specimen Application Program (TSAP) as "The 'synthetic application' used to check/verify the PLC functionality needed to support the qualification test program. A TSAP is required for a meaningful system-level test of the PLC, and the TSAP should exercise important hardware and software capabilities as required in the text."

Section 6.2.2 of EPRI TR-107330 defines the configuration requirements for a TSAP to exercise all of the important hardware and software capabilities of the system. This section defines program features such as providing serial output data, timers, control loops, and other typical PLC program features. Section 6.2.2 also states that the TSAP must be developed using the applicable portions of Section 8.6 (Qualification Documentation Requirements) and Section 7 (Quality Assurance) and its subsections.

The EPRI TR-107330 requirements help to achieve a "generic qualification" by using a TSAP that artificially uses all logic constructs and exercising all vendor-offered hardware. The purpose of this activity is to ensure that when a utility uses a qualified PLC, the PLC hardware and software functionality has been fully tested.

In Toshiba's NRW-FPGA-Based PRM system qualification project, the Test Specimen being qualified will have the actual PRM system logic embedded in the FPGAs. This approach meets the intent of the TSAP in EPRI TR-107330, which is provided to test the range of possible PLC program features that may be employed when the PLC is programmed for a specific application to ensure that the system-level test is meaningful.

10.3 Applicability of EPRI TR-107330 Section 5.6, "Application Software Objects Acceptance Testing."

Section 5.6 of the EPRI TR-107330 defines the requirements for "Acceptance testing of the software objects in the PLC library." For the NRW-FPGA-Based PRM System being qualified in this project, functional elements are equivalent to the software

objects.

This requirement is satisfied by only using functional elements which full pattern tested and accepted prior to being placed in the functional element library. Further, the FPGAs are then subjected to 100% toggle testing. The testing is designed to ensure that all basic functionality is exercised.

11. Documentation of Results

The primary deliverable documents for the testing phase of this project are:

1. Test Reports for each phase, i.e., Pre-Qualification Test Report, Qualification Test Reports, and Performance Proof Test Report. Each Test Report summarizes the results of the testing conducted for that phase.
2. Completed test procedures and associated data sheets, i.e., original test procedures that include the written indications made by test personnel at each procedure step that requires documentation of completion, etc.
3. Documentation of any test deviations, nonconformances, maintenance and/or configuration changes.
4. Qualification Test Summary Report
5. Test System Configuration Documentation (Drawings, programs, etc.)

The ERS section 9, which is compliance with Section 8 of the EPRI TR-107330, defines the required documentation to be delivered. In addition to specific test records and reports, other supporting documents such as drawings, equipment data, and engineering reports will be provided. These documents are identified in the Project Document Control Documents List (PCDL) in accordance with Document Control Procedure (AS-100A004).

Any other records generated as part of this project but not identified as a deliverable document shall be controlled in accordance with project specific QA record control procedure and will be available for audit in Toshiba files.

APPENDIX 1 DESCRIPTION OF EQUIPMENT

Test Specimen Units consist of three PRM Units as follows:

- LPRM Unit,
- LPRM/APRM Unit, and
- FLOW Unit.

In addition, the cable connection between Test Specimen Units and the spare modules that are the same type of modules installed in the Test Specimen Units are a part of the Test Specimen.
A listing of the units, spare modules and the cables to be qualified is provided as below.

Table A1-1 Listing of the Test Specimen

Type	Model #	Description	Quantity
Unit	HNU 100	LPRM Unit	1
Unit	HNU 200	LPRM/APRM Unit	1
Unit	HNU 300	FLOW Unit	1
Interconnecting cable	[ ]a,c	Optical Cable, Cable Length: 3 m (Vendor: [ ]a,c [ ]a,c)	4
Spare Module	HNS011	LPRM Module	5
Spare Module	HNS020	APRM Module	1
Spare Module	HNS030	SQ-ROOT Module	1
Spare Module	HNS040	FLOW Module	1
Spare Module	HNS091	STS Module	1
Spare Module	HNS093	STS Module	1
Spare Module	HNS490	BLANK Module	1
Spare Module	HNS500	LVPS Module	1
Spare Module	HNS511	AO Module	5
Spare Module	HNS512	AO Module	5
Spare Module	HNS513	AO Module	3

Type	Model #	Description	Quantity
Spare Module	HNS514	AO Module	7
Spare Module	HNS520	DIO Module	1
Spare Module	HNS530	TRN Module	1
Spare Module	HNS540	RCV Module	1
Spare Chassis	22890-353_ HNU100_L PRM12	Chassis for LPRM Unit (Vendor:Schroff)	1
Spare Chassis	22890_354_ HNU200_A PRM	Chassis for LPRM/APRM Unit (Vendor:Schroff)	1
Spare Chassis	22890-355_ HNU_300_ FLOW	Chassis for FLOW Unit (Vendor:Schroff)	1
Spare Module (for EMC tests)	HNS013	LPRM Module (enhanced noise-withstand-capability of HNS011)	27
Spare Module (for EMC tests)	HNS515	AO Module (enhanced noise-withstand-capability of HNS511)	7
Spare Module (for EMC tests)	HNS516	AO Module (enhanced noise-withstand-capability of HNS512)	8
Spare Module (for EMC tests)	HNS517	AO Module (enhanced noise-withstand-capability of HNS513)	5
Spare Module (for EMC tests)	HNS518	AO Module (enhanced noise-withstand-capability of HNS514)	11

Note: Spare modules for EMC (EMI/RFI, Surge Withstand Capability, EFT/B, ESD, and Class-1E to Non-1E Isolation) Tests are added in revision 2 to confirm the enhanced noise-withstand-capabilities of these modules. These modules are installed in the Test Specimen Units instead of the modules originally installed during EMC Tests. These modules are not subject to aging effect during Environmental and Seismic Tests. So these modules are removed from and original modules are installed in the Test System in the Performance Proof Test.

The Master Configuration List (MCL) is a controlled project document that provides a listing of the specific modules and cables that comprise the Test Specimen (not including testing equipment, which will be specified separately in the individual test procedures and drawings). The serial numbers of all modules are documented in the MCL and are maintained with any required equipment changes.

Schematic Diagram is developed to clarify the configuration and arrangement of the Test Specimen in accordance with the wiring design requirements as shown in PTER section 4.3.3.1.

Test Equipment that is used to support the testing are listed in Table A1-2. Test Equipment shall be selected in accordance with the requirements shown in section 6.3.
The Test Equipment categorized as Measurement and Test Equipment (M&TE) shall be calibrated.
The serial numbers of the Test Equipment used in a certain test shall be recorded in the corresponding test record.

Table A1-2 Test Equipment List

Name		Model #	Type of Equipment	Quantity	Note
Trip Auxiliary Unit		---	Test Support Equipment	1	
FLOW Unit		HNU300	Test Support Equipment	1	
DI/DO Simulator		---	Test Support Equipment	1	
LPRM/FLOW Signal Simulator		---	Test Support Equipment	1	
	Arbitrary Waveform Generator	[ ]a,c	M&TE	1	Supporting LPRM/FLOW Signal Simulator's Function
	Programmable DC Voltage Generator		M&TE	2	Supporting LPRM/FLOW Signal Simulator's Function
Current Voltage Conversion Box (Current Monitor Box)		TOSHIBA DEP-03102	M&TE	1	
AC Power Supply (Variable Power Supply)		[ ]a,c	M&TE	1	
Rack		---	Test Support Equipment	1	
Data Acquisition Unit (Data Recorder)	Low Speed	[ ]a,c	M&TE	3	
	Transient		M&TE	3	
Cables external to the Test Specimen		---	Test Support Equipment	1	

System Set-up and Check-out Test Procedure (FPG-TPRC-C51-1001) provides the detailed step by step instructions for setup of the Test Specimen and Test Equipment in accordance with the ECWD.

APPENDIX 2 PRE-QUALIFICATION TEST PLAN

1. GENERAL

The Pre-Qualification Test, which is performed prior to the Qualification Testing, demonstrates that the Test Specimen operates as intended, and provides a performance baseline for the qualification tests.

The system with NRW-FPGA requires no application software objects in the test.

All parameters and switches of each module associated with the Test Specimen are set and checked in the System Set-up and Check-out Test.

The Burn-in Test is carried out on the Test Specimen to detect any failures in early life that would corrupt the Qualification Test results during the 352 hours continuous operation of Test Specimen.

The Operability Test and the Prudency Test are performed to establish the baseline performance. The Operability Test is performed in order to demonstrate the functionality of the Test Specimen, and the Prudency Test is performed to demonstrate the operability of the Test Specimen under highly dynamic conditions. The test requirements are shown in the ERS section 7.2.

Table 4-1 and Figure 4-1 show the order for the Pre-Qualification Tests, and the applicable procedures. The Pre-Qualification Tests are as follows:

(1) **System Set-up and Check-out Test (FPG-TPRC-C51-0001).** The purpose of this test is to verify proper assembly, integration and operation of the assembled qualification Test System for Pre-Qualification Testing in Toshiba's facility. This test confirms proper connection and operation of whole Test System including monitoring instruments, power supplies, signal simulators, and communication links.

(2) **Burn-in Test (FPG-TPRC-C51-0001).** The purpose of this test is to perform a minimum 352 hours burn-in of the assembled qualification Test System. The objective of the test is to detect any failures in early life that might otherwise impact the subsequent qualification test activities.

(3) **System Set-up and Check-out Test (FPG-TPRC-C51-1001).** After the Burn-in Test, the Test Equipment is transported to [ ]^{a,f} in U.S.A from Toshiba, and the System Set-up and Check-out Test is performed prior to the beginning of the Operability Test. The purpose of this test is to verify proper assembly, integration and operation of the assembled Test System in [ ]^{a,c} This test confirms proper connection and operation of the whole Test System including monitoring instruments, power supplies, signal simulators, and communication links.

(4) **Operability Test (FPG-TPRC-C51-1009).** The purpose of this test is to verify the Test System functions correctly prior to the performance of qualification tests. This initial performance confirmed in the Operability Test also establishes the baseline performance of the Test System, which can be used for comparison to the performance measured during qualification tests.

(5) **Prudency Test (FPG-TPRC-C51-1010).** The purpose of this test is to verify the Test System functions correctly while being exercised in various ways to simulate potential in-service stresses prior to the performance of qualification tests. This initial performance of the Prudency Test also establishes baseline performance of the Test System for comparison to the performance measured during qualification tests.

Environmental conditions for the testing prior to the qualification tests are "Normal environmental conditions" as described in ERS section 5.5.1.

2. REFERENCE

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. The test setup information, described in the Pre-Qualification Test procedure, indicates the mounting method and interfaces of the equipment. During the Pre-qualification Test, equipment is configured as shown on the ECWD developed in accordance with PTER section 4.3.3.1

4. ACCEPTANCE CRITERIA

For the System Set-up and Check-out testing, acceptance criteria include verifying that the Test System is correctly configured in accordance with the applicable drawings.

For the Burn-in testing, the acceptance criteria are that Test Specimen shall pass the Operability Tests following the Burn-in Test. If any failure occurs, the failed component shall be replaced and the replaced items burned in are retested.

ERS Section 7.2 provides the detailed acceptance criteria for the Operability and Prudency Testing performed during the Pre-Qualification Tests. In general, the ERS acceptance criteria are as follows:

- For Operability Testing: Acceptance criteria are provided for accuracy, response time, discrete input and output operability, response to loss of power, and response to power interruption.

- For Prudency Testing: Acceptance criteria are provided for response time for the burst of events test (in EPRI TR-107330) and the response to fault simulation test.

Detailed acceptance criteria are specified in the Operability Test Procedure and Prudency Test Procedure.

5. RECORDS

(1) Pre-Qualification Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 3 ENVIRONMENTAL TEST PLAN

1. GENERAL

Environmental Testing is performed to assure that the NRW-FPGA-Based PRM System provides the performance required under the environmental conditions shown in the ERS section 5.5.1. These conditions shown in the ERS comply with the conditions shown in EPRI TR-107330.

The required conditions of temperature and humidity under (and after) which the Test Specimen operates normally are shown in the ERS section 5.5.1.

According to the requirement of ERS section 7.3.2.11, the power quality tolerance test is performed during acceptance test, and at the end of the elevated temperature test while still at high temperature and following the Seismic Test. Input voltage ranges and frequency ranges of power supplies for connection to an AC (and DC) source are given in the ERS section 5.5.8, and the margin is given in IEEE Std 323-1983 (Reference 2. (2)).

The radiation exposure is also required for the environmental evaluation in the ERS section 5.5.1. The gamma irradiation on the NRW-FPGA-Based PRM System Test Specimen is performed to 11 Gy to provide 10% margin above the requirement of 10 Gy. The 10 Gy exposure requirement is stated in ERS section 5.5.1 and satisfies the EPRI TR-107330 requirement from section 4.3.6.1. The Radiation Exposure Test is performed in accordance with the guidance of IEEE Std 323-1983.

Normal environmental basic conditions in this test are shown in the ERS section 5.5.1. These conditions are maintained unless otherwise specified for this testing.

Abnormal environmental conditions for each Environmental Test are defined according to the ERS section 5.5.1, considering the margins for each condition.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units
(2) IEEE Std 323-1983, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. The test facility will provide equipment needed to perform this Environmental and Radiation testing in accordance with procedures that are reviewed and approved by Toshiba. The test facility equipment shall be calibrated in accordance with approved procedures.

The test setup information in the Environmental Test indicates the mounting method and interfaces of the Test System.

4. SEQUENCE OF TESTS

The Environmental Tests are performed in the following order:

(1) Radiation Exposure
(2) Temperature & Humidity
(3) Power Source Test (at the end of the elevated temperature test while still at high temperature)

Radiation exposure testing is performed at a test laboratory subcontracted by[ ]^{a,c}
Prior to the Temperature & Humidity test, a System Set-up and Check-out Test is performed.
Toshiba will perform an audit of[ ]^{a,c}to determine whether[ ]^{a,c}shipping procedures meet Toshiba's requirements. If Toshiba determines that the additional shipping requirements are required, then Toshiba will add these requirements to Toshiba's

purchase specification for[ ]a,c testing services.

5. DESCRIPTION OF TEST PROCEDURE

5.1. Radiation Exposure Test

The purpose of this test is to demonstrate that the Test Specimen Units will not experience failures or unacceptable degradation due to expected radiation exposure service conditions.

The Test Specimen is installed in a radiation test chamber during the exposure. The spare modules and spare chassis (except the modules prepared for EMC tests) shall also be in the radiation test chamber during the exposure. The test facility provides instrumentation for verification of radiation exposure test levels.

The Test Specimen Units shall be subjected to the total dose of 11 Gy gamma radiation (to satisfy the ERS section 5.5.1 of 10 Gy with 10% margin) by ^{60}Co gamma ray source. The dose rate used in this test shall be sufficient to ensure the exposure of 11 Gy over the test irradiation time.

5.2. Temperature and Humidity Test

The purpose of this test is to demonstrate that the Test Specimen will not have experience of failures or unacceptable degradation due to expected normal and abnormal service conditions of temperature and humidity. The Operability and Prudency Tests are performed at various points throughout this test.

The Test Specimen is installed in an environmental test chamber during the test. The Test Specimen Units shall operate during the test, with application of simulated inputs and monitoring and data acquisition of inputs and outputs shown in MTP Section 6.1. The spare modules and spare chassis (except the modules prepared for EMC tests) shall also be in the environmental test chamber during the test, however, these spare parts are not powered during the test. [ ]a,c provides instrumentation for verification of

temperature and humidity levels in this test.

(1) The temperature and humidity environmental profile (1 cycle) is shown in ERS Figure 5-2.

Temperature and humidity environmental tests are performed in the following order:

(1) High temperature (at least 48 hours)
(2) Operability Test (High Temperature and Humidity)
(3) Prudency Test (High Temperature and Humidity)
(4) Power Source Test (High Temperature and Humidity)
(5) Low Temperature and Low Humidity (including initial ramp down over 4 hours, followed by a hold period of at least 8 hours)
(6) Operability Test
(7) Ambient Environment (ramp up over 4 hours, followed by a hold period until environmental conditions stabilize).
(8) Operability Test

5.2.1 Mounting

For these tests, the chassis are mounted in the environmental test chamber on a simple structure that does not enclose the chassis. The environmental air is monitored at the bottom of each unit. No additional cooling fan is included in the chamber.

Minimum monitoring points for environmental condition are as follows:

- Bottom of each unit (LPRM/APRM, LPRM, FLOW).
- Spare module installation points

All Test Specimen Units are tested simultaneously, hence at least three points are monitored during this test. Control data for environmental conditions is provided by the sensor that monitors the bottom unit in the test rack.

5.2.2 Low Temperature and Humidity

For the low temperature exposure test, if the specified low relative humidity cannot be achieved for the specified temperature, then proceed as follows:

- Run the test for the specified time at the low temperature and at the lowest relative humidity that can be achieved at the specified temperature (including initial ramp down over 4 hours, followed by a hold period of at least 8 hours);
- Then, run the test at the lowest temperature that the low specified relative humidity can be achieved (including initial ramp down over 4 hours, followed by a hold period of at least 8 hours).

The abnormal temperature and humidity environmental test is required as aging conditioning.

5.3. Power Sources Test

The power sources test shall confirm whether the Test Specimen operates correctly within the following AC power supply voltage and frequency ranges.

- Voltage range: 90-150 VAC per ERS Section 5.5.8; plus 10% margin required by IEEE Std 323-1983 Section 6.3.1.5 (4). Therefore, the required test voltage range is 81-165 VAC.
- Frequency range: 57-63 Hz per ERS Section 5.5.8; plus 10% margin required by IEEE Std 323-1983 Section 6.3.1.5 (5). Therefore, the required test frequency range is 51-70 Hz.

This test is performed at the end of the elevated temperature test while still at high temperature.

6. ACCEPTANCE CRITERIA

During the testing, the Test Specimen Units shall be:

- Capable of normal processing of input data and producing output data.
- Able to perform its safety functions as required in ERS section 4.1.2. Specifically, the Test Specimen shall meet the acceptance criteria specified for the Operability and Prudency Testing at the specified points. (See Chapter 3 for general acceptance criteria for Operability and Prudency Tests.)

Following Environmental Testing, the Test Specimen Units shall be:

- Structurally intact. Specifically, the Test Specimen shall be examined to ensure no parts are damaged or loosened.
- Able to perform its safety functions as required in ERS section 4.1.2. Specifically, the Test Specimen shall meet the acceptance criteria specified for the Operability Testing at the end of the testing. (See Appendix 2 for general acceptance criteria for Operability Test)

During and after the testing, the performance of the Test Specimen shall be compared with the baseline performance (measured during Pre-Qualification testing) to determine if the testing impacted the performance and operability of the Test Specimen.

Detailed acceptance criteria are specified in the procedure for this test.

7. RECORDS

(1) Environmental Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 4 SEISMIC TEST PLAN

1. GENERAL

Seismic Testing is performed to assure that the Test Specimen Units provides the performance and seismic withstand capability under Seismic Test conditions shown in the ERS section 5.5.2. These conditions shown in the ERS comply with the conditions shown in EPRI TR-107330 to the extent achievable at[ ]^{a,c}

This testing involves the following activities:

- Mounting of the Test Specimen Units on a vibration table;
- Setting up the Test System;
- Performing a System Set-up and Check-out Test to verify correct setup;
- Performing a Resonance Search test;
- Performing five tri-axial Seismic Tests representative of an Operating Basis Earthquake (OBE) to perform "seismic aging" of the Test Specimen, followed by an inspection to verify structural integrity of the affected Test System components;
- Performing a Seismic Test representative of a Safe Shutdown Earthquake (SSE), followed by an inspection to verify structural integrity of the affected Test System components;
- Performing an Operability Test to compare the system performance to baseline performance.

Figure 5-3 of the ERS shows the required response spectra (RRS) for the OBE and SSE. The peak amplitudes of this figure are shown in the table below.

Seismic Event	Amplitude Requirement from ERS Section 5.5.2 and EPRI TR-107330 Section 4.3.9	Achievable Amplitude
OBE	9.8 g	The achievable amplitude will be identified during the seismic testing and reported in the test report.
SSE	14 g	

Based on information provided by[ ]a,c Toshiba expects that the vibration test facility at [ ]a,c will not be capable of providing a test with this ERS spectra requirement. Accordingly, Toshiba will negotiate with [ ]a,c to determine the achievable spectra for the Seismic Test of the Test Specimen. This MTP will then be revised to reflect the achievable test spectra at[ ]a,c

Environmental conditions during Seismic testing are kept at "Normal environmental basic conditions" shown in ERS section 5.5.1.

1.1 Seismic Test Mounting

The Test Specimen is mounted on a structure that is stiff enough so that there is no resonance below 100Hz with the Test Specimen mounted on it.

For the Test Specimen Units, each of the three chassis is fixed to the vibration table as follows:

- Prepare four metal blocks per one unit (hence total 12 blocks are needed).
- Attach metal blocks on the vibration table by welding. The attachment positions of the metal blocks are determined as required to fix the units to the table.
- Make screw holes in the blocks as needed to allow the chassis to be bolted to each block.
- Attach the units to the mounting blocks using screws. Torque the screws in accordance with[ ]a,c test procedure.

If it is difficult to fix the block directly to the vibration table, the metal blocks are fixed to a metal plate (prepared by[ ]a,c, and the metal plate is fixed to the vibration table by welding.

The personnel of [ ]a,c prepare the mounting blocks as needed to accommodate the dimensions of the units and the screws specified by Toshiba. The personnel of[ ]a,c shall weld these blocks into position on the vibration table.

[ ]a,c personnel shall document details of the mounting block configuration in the test

procedures that [ ]^{a,c} creates. Toshiba shall review and approve the mounting details prior to the start of the testing.

1.2 Seismic Test Measurement

In addition to control accelerometer, one or more Test Specimen response accelerometer shall be mounted on each chassis (PRM consists of three chassis). The accelerometers are located to establish the maximum acceleration that occurs on the vibration table, and on each chassis, in each of the three orthogonal directions.

Minimum monitoring points for vibration is as follows:

(1) Test Specimen: Top of each unit (LPRM/APRM, LPRM, FLOW) (three orthogonal directions).
(2) Vibration table directly (Control Accelerometer) (three orthogonal directions).

Vibrations are simultaneously applied to the Test Specimen Units. Hence at least nine points on the chassis, and three on the vibration table, are monitored during this test.

1.3 Seismic Test Spectrum Analysis

In addition to reporting the Test Response Spectrum from the control and Test Specimen Response accelerometers at the damping given in ERS Figure 5-3, the spectrum is also reported for 1/2, 1, 2 and 3% damping as shown in ERS Section 7.3.2.6.2.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units
(2) IEEE Std 344-1987, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations"

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. [ ]^{a,c}will provide the equipment needed to perform this Seismic Testing in accordance with procedures that are reviewed and approved by Toshiba. [ ]^{a,c}equipment shall be calibrated in accordance with approved procedures.

The test setup information in the Seismic Test Procedure indicates the mounting method and interfaces of the Test System.

4. SEQUENCE OF TESTS

The Seismic Testing is performed in the following order:

(1) Resonance Search
(2) Five tri-axial OBEs for aging
(3) One tri-axial SSE following the OBEs
(4) Operability Test
(5) Prudency Test
(6) Power Source Test

5. DESCRIPTION OF TEST PROCEDURE

The Test Specimen is installed on a vibration table during the test. [ ]^{a,c}is required to fabricate the table mounting brackets for the Test Specimen. The Test Specimen is operating during the test, with application of simulated inputs and monitoring and data acquisition of inputs and outputs shown in MTP Section 6.3. [ ]^{a,c}provides instrumentation for verification of seismic motion of the vibration table and all test items.

5.1. Resonance Search

The resonance search shall be performed as follows:

- For each direction (X, Y or Z),
- Input Level: 0.2G,
- Frequency Range: 1Hz – 100Hz, and
- Sweep rate: Two octaves per minute or less.

The Test Specimen Units are in "power off" during the resonance search test.
The purpose of this test is to determine whether the Test Specimen has a resonance point in each orthogonal direction (IEEE Std. 344-1987 7.1.4.1).

5.2. Tri-axial Seismic Withstand Capability Test

The tri-axial seismic withstand capability testing includes the following tests:

(1) Seismic Tests for aging: Five tri-axial OBEs
(2) Seismic Test: One tri-axial SSE
(3) Operability Test
(4) Prudency Test

When this level of vibration is applied, and additionally in the case of 1/2, 1, 2 and 3% damping, the spectra of the seismic control accelerometers and the accelerometers attached to the Test Specimen are measured.

Tri-axial seismic Tests are done with the independent motions in all three orthogonal directions. To provide statistically independent simulated motions, the table time histories should have the coherence values of less than 0.5 when computed with at least 12 data samples. Alternatively, an absolute value of less than 0.3 correlation coefficient unit for all time delays may be used. (IEEE Std. 344-1987 7.6.6.3, Appendix E)

The duration of each OBE and the SSE shall be 30 seconds minimum.

After Resonance Search and Seismic Testing, an Operability Test (ERS section 7.2.4) and Power Source Test are performed. The power sources test shall confirm whether the Test Specimen Units operates correctly within the following AC power supply voltage and frequency ranges.

- Voltage range: 90-150 VAC per ERS Section 5.5.8; plus 10% margin required by IEEE Std 323-1983 Section 6.3.1.4 (4).
  Therefore, the required test voltage range is 81-165 VAC.
- Frequency range: 57-63 Hz per ERS Section 5.5.8; plus 10% margin required by IEEE Std 323-1983 Section 6.3.1.4 (4).
  Therefore, the required test frequency range is 51-70 Hz.

6. ACCEPTANCE CRITERIA

During the testing, the Test Specimen Units shall be:

- Capable of normal processing of input data and producing output data.
- Capable of normal function of relay output from the DIO modules.

Following Seismic Testing, the Test Specimen Units shall be:

- Structurally intact. Specifically, the Test Specimen shall be examined to ensure no parts are damaged or loosened.
- Able to perform its safety functions as required in ERS section 4.1.2. Specifically, the Test Specimen shall meet the acceptance criteria specified for the Operability Testing following the SSE. (See ERS Section 7.2.2 for general acceptance criteria for Operability Test.)

Following testing, the performance of the Test Specimen shall be compared to the baseline performance (measured during Pre-Qualification Testing) to determine if the testing impacted the performance and operability of the Test Specimen.

Further, the Test Specimen shall have no resonances in the frequency range tested.

Detailed acceptance criteria are specified in the procedure for this test.

7. RECORDS

(1) Seismic Test Report
(2) Completed Test Procedures and Attachments
(3) Test Response Spectrum data

APPENDIX 5 EMI/RFI TEST PLAN

1. GENERAL

The purpose of this test is to demonstrate the suitability of the Test Specimen Units for qualification as a safety-related device with permissible EMI/RFI emissions and susceptibility.

EMI/RFI Testing is performed to assure that the NRW-FPGA-Based PRM System withstands the EMI/RFI levels given in the ERS, section 5.5.3. The EMI/RFI levels shown in the ERS comply with the levels shown in NRC Regulatory Guides (RG) 1.180 rev.1.

Note that the test levels specified in this test plan are not the same as those specified in the EPRI TR-107330 requirements. Instead, the test levels used in this test plan are obtained from Regulatory Guide 1.180, Revision 1, which was issued in October 2003. These new Regulatory Guide values are considered by Toshiba to better reflect the current requirements of US utilities. Note that EPRI TR-107330 was published in December 1996, prior to issuance of Revision 1 of Regulatory Guide 1.180.

The EMI/RFI susceptibility and emissions withstand capability given in NRC Regulatory Guide 1.180 rev. 1 will be tested using the following test methods from Test methods MIL-STD 461E:

Test Type	Test Method
(a) Low-Frequency Conducted Susceptibility (Power):	CS101
(b) High-Frequency Conducted Susceptibility (Power):	CS114
(c) High-Frequency Conducted Susceptibility (Signal):	CS114
	CS115
	CS116
(d) Radiated Susceptibility, Magnetic Field:	RS101
(e) Radiated Susceptibility, Electric Field:	RS103
(f) Low-Frequency Conducted Emissions:	CE101
(g) High-Frequency Conducted Emissions:	CE102

(h) Radiated Emissions, Magnetic Field: RE101
(i) Radiated Emissions, Magnetic Field: RE102

The order of these tests may be interchanged. Prior to the first EMI/RFI Test, a System Set-up and Check-out Test shall be performed.

Environmental conditions are kept at "Normal environmental basic conditions" shown in ERS section 5.5.1.

1.1 Test Level

EMI / RFI testing is performed to the levels and for the emission types specified in chapter 4 of this appendix.
In the susceptibility tests, testing will initially be performed for 100% of the test levels specified in the ERS, and the Test Specimen performance shall be monitored. If the Test Specimen performance is acceptable, no further susceptibility testing shall be required. If the Test Specimen shows susceptibility, the testing will be repeated at progressively lower test levels until acceptable performance of the Test Specimen is achieved.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units
(2) U.S. NRC Regulatory Guide RG-1.180 Revision 1, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," revised October 2003, Chapter 3 and 4
(3) MIL-STD-461E "Requirements for the control of electromagnetic interference characteristics of subsystems and equipment" dated August 1999

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. [ ]^{a,c} will provide equipment needed to perform this EMI/RFI Testing in accordance with procedures that are reviewed and approved by Toshiba. [ ]^{a,c} equipment shall be calibrated in accordance with approved procedures.

The test setup information in the EMI/RFI Test procedure indicates the mounting method and interfaces of the Test System.

4. DESCRIPTION OF TEST PROCEDURE

The Test System is installed in an anechoic chamber during the test. The Test System is operating during the test, with application of limited simulated inputs, and monitoring and data acquisition of inputs and outputs. [ ]^{a,c} provides instrumentation for measurement and verification of EMI/RFI Test levels.

This section summarizes the test procedure. [ ]^{a,c} shall prepare test procedures describing the test activities (including the method for application of EMI/RFI to the Test Specimen) according to this section prior to the beginning of testing.

The Test Specimen Units are connected to ground using the grounding conductors to a ground bus located at the base of the mounting surface.

4.1. Conducted Susceptibility (Power Leads)

4.1.1. Low-Frequency Conducted Susceptibility (Power Leads)

This test is performed on the input power leads of AC power sources. The test is performed according to MIL-STD-461E CS101. Envelope limits are shown in Figure 5-4 of the ERS. Testing is performed from 120 Hz (second harmonic of the power line frequency) to 150 kHz as stated in Section 5.5.3.1 of the ERS.

4.1.2. High-Frequency Conducted Susceptibility (Power Leads)

This test is performed to the input power leads to the AC power sources. The test is performed according to MIL-STD-461E CS114. Data are reported in dBmicroA. Envelope limits are shown in Figure 5-5 of the ERS. Testing is performed from 10 kHz to 30 MHz.

4.2. Conducted Susceptibility (Signal Leads)

4.2.1. High-Frequency Conducted Susceptibility (Signal Leads)

This test is performed on all signal leads in accordance with MIL-STD-461E CS114. The envelope is set from 10 kHz to 30 MHz, and 91 dBmicroA.

4.2.2. High-Frequency Conducted Susceptibility (Signal Leads – Impulse Excitation)

This test is performed according to MIL-STD-461E CS115. The operating envelope is set to 2A.

4.2.3. High-Frequency Conducted Susceptibility (Signal Lead – Damped Sinusoidal Transients)

This test is performed according to MIL-STD-461E CS116. The operating envelope is set to 5A. Testing is performed from 10 kHz to 100 MHz.

4.3. Radiated Susceptibility, Magnetic Field

This test is performed according to MIL-STD-461E RS101. The Test Specimen shall be installed in close proximity (< 1 m) to sources of large magnetic fields (> 600 A/m). The frequency is set from 30 Hz to 100 kHz. The test level is shown in Figure 5-6 of the ERS.

4.4. Radiated Susceptibility, Electric Field

This test is performed according to MIL-STD-461E RS103. The test frequency is set from 30 MHz to 1 GHz, and the impressed electric field level is 10 V/m for all frequencies. The test is performed with both vertical and horizontal polarized waves.

4.5. Low-Frequency Conducted Emissions

This test is performed on the power input leads, according to MIL-STD-461E CE101. Envelope limits are the "envelope for less than 1kVA AC" limits shown in Figure 5-7 of the ERS. Data is reported in dBmicroA. The frequency range is from 60 Hz to 10 kHz

4.6. High-Frequency Conducted Emissions

This test is performed on the power input leads, according to MIL-STD-461E CE102. Recommended emissions limits are shown in Figure 5-8 of the ERS. The test frequency is set from 10 kHz to 2 MHz. No emissions control technique shall be used in this test. Data is reported in dBmicroV.

4.7. Radiated Emissions, Magnetic Field

This test is performed according to MIL-STD-461E RE101. Envelope limits are shown in Figure 5-9 of the ERS. The test Frequency is set from 30 Hz to 100 kHz. All measurements should be performed at 7 cm, as specified by RE101.

4.8. Radiated Emissions, Electric Field

This test is performed according to MIL-STD-461E RE102. Recommended emissions limits are shown in Figure 5-10 of the ERS. The test frequency is set from 2 MHz to 1 GHz. This test is performed with both vertical and horizontal polarized waves.

5. ACCEPTANCE CRITERIA

During the EMI/RFI Testing as specified in ERS Section 5.5.3, the Test Specimen Units shall be:

- Capable of normal processing of input data and producing output data during the EMI/RFI Test signal application.
  Able to perform its safety functions as required in ERS section 4.1.2.

- Specifically, the Test Specimen shall meet the acceptance criteria specified for the Operability and Prudency Tests after the application of EMI/RFI Test signal application.

The performance of the Test Specimen during the testing shall be compared to the baseline performance (measured during Pre-Qualification Testing) to determine if the testing impacted the performance and operability of the Test Specimen.

In addition, the emissions of the Test Specimen shall not exceed the limiting values specified in ERS section 5.5.3.

Detailed acceptance criteria are specified in the procedure for this test.

6. RECORDS

(1) EMI/RFI Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 6 SURGE WITHSTAND CAPABILITY TEST PLAN

1. GENERAL

The purpose of this test is to demonstrate the suitability of the Test Specimen Units for qualification as a safety-related device with Surge Withstand Capability. As stated in ERS section 5.5.4, IEC 61000-4-5 and IEC 61000-4-12 tests are performed.

Surge Withstand Capability Testing is performed to assure that the Test Specimen Units withstands the surge limits given in the ERS section 5.5.4. The Surge Withstand Capability Test levels shown in the ERS comply with the level shown in NRC Regulatory Guides (RG) 1.180 rev.1 (Reference 2 (2)).

Surge Withstand Capability Tests should be performed in the same location as the EMI/RFI Test. If Surge Withstand Capability Test should be performed in another place, a System Set-up and Check-out Test shall be performed prior to the test.

Environmental conditions are kept at "Normal environmental basic conditions" shown in ERS section 5.5.1.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units
(2) U.S. NRC Regulatory Guide RG-1.180 Revision 1, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," revised October 2003, chapter 5
(3) IEC61000-4-5: 1995, "Surge immunity test", Amendment 1 (2000)
(4) IEC61000-4-12: 1996, "Oscillatory Waves Immunity Tests" (1996)

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. [ ]^{a,c} will provide equipment needed to perform this Surge Withstand Capability Testing in accordance with [ ]^{a,c} procedures that are reviewed and approved by Toshiba. [ ]^{a,c} equipment shall be calibrated in accordance with approved procedures.

The test setup information in the Surge Withstand Capability Test Procedure indicates the mounting method and interfaces of the Test System.

4. DESCRIPTION OF TEST PROCEDURE

The Test System may be installed in an anechoic chamber during the test; however the chamber may be open. The Test System is operating during the test, but the sensitive signal simulation, data acquisition, and monitoring equipment is not connected during addition of the actual test surges. [ ]^{a,c} provides instrumentation for measurement and verification of applied Surge Test levels.

This test is applied to power lines and outer conductors (shields) of all cables that connect to external equipment unless the ERS specifies that the cables must be run in continuous conduits, and the ground system is common between both ends of the cable. Connection to cables or lines will be made according to the selected standard with a nominal source impedance of 10 ohms.

4.1. Surge (Ring Wave)

This test is performed according to IEC 61000-4-12.

Limits (Applied peak voltage)

- Voltage = 2 kV : for secondary or derived power distribution systems

Pulse Shape

・100 kHz, ring wave (0.5 micro second rise time, 10 micro second pulse width)

4.2. Surge (Combination Wave)

This test is performed according to IEC 61000-4-5 Level 3.

Limits (Applied peak voltage)

・Voltage = ±2 kV : for secondary or derived power distribution systems

Pulse Shape

・Impulse of 1.2 micro second (±30 %) rise time, 50 micro second pulse width, open circuit, double exponential

・Impulse of 8 micro second (±20 %) rise time, 20 micro second pulse width, short circuit, double exponential

Repetition

・30-120 seconds between Surge Withstand Capability Tests

Number of tests

・At least five positive and five negative at the selected points

4.3 Application Points (ERS Section 5.5.4)

Surges shall be applied to following points:

(1) Between line and neutral for AC connections to the power supplies.
(2) Between line for AC connections to the power supplies and the chassis ground.
(3) Between neutral for AC connections to the power supplies and the chassis ground.

If there are more than one module or input of the same type, surges or EFT/B can be applied to only one representative module for each type.
The Surge Withstand Capability Test Procedure will specify the exact locations for application of surge, based on the list of points required above.

5. ACCEPTANCE CRITERIA

During the application of the surge as specified in ERS section 5.5.4, the Test Specimen Units shall be capable of normal processing of input data and producing output data.
In addition, the application of the specified surge levels shall not damage any module or device, or cause disruption of operation that could result in a loss of safety related function.

Detailed acceptance criteria are specified in the procedure for this test.

6. RECORDS

(1) Surge Withstand Capability Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 7 EFT / B TEST PLAN

1. GENERAL

The purpose of this test is to demonstrate the suitability of the Test Specimen Units for qualification as a safety-related device with EFT/B withstand capability. As stated in ERS section 5.5.5, IEC 61000-4-4 test is performed.

EFT/B withstand testing is performed to assure that the Test Specimen Units withstands the surge limits given in the ERS section 5.5.5. The EFT/B Test levels shown in the ERS comply with the level shown in NRC Regulatory Guides (RG) 1.180 rev.1 (Reference 2. (2)).

EFT/B Testing should be performed in the same location as the EMI/RFI Test. If EFT/B Test should be performed in another place, a System Set-up and Check-out Test shall be performed prior to the test.

Environmental conditions are kept at "Normal environmental basic conditions" shown in ERS section 5.5.1.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units

(2) U.S. NRC Regulatory Guide RG-1.180 Revision 1, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems," revised October 2003, chapter 5

(3) IEC61000-4-4: 1995, "Electrical fast transient / burst immunity test", Amendment 1 (2000), Amendment 2 (2001)

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. [ ]^{a,c} will provide equipment needed to perform this EFT/B Testing in accordance with procedures that are reviewed and approved by Toshiba. [ ]^{a,c} equipment shall be calibrated in accordance with approved procedures.

The test set-up information in the Surge Withstand Capability Test procedure indicates the mounting method and interfaces of the Test System.

4. DESCRIPTION OF TEST PROCEDURE

The Test System may be installed in an anechoic chamber during the test; however the chamber may be open. The Test System is operating during the test, but sensitive signal simulation, data acquisition, and monitoring equipment is not connected during application of the actual test EFT/B pulses. [ ]^{a,c} provides instrumentation for measurement and verification of applied EFT/B Test levels.

This test is applied to power lines and outer conductors (shields) of all cables that connect to external equipment unless the ERS specifies that the cables must be run in continuous conduits, and the ground system is common between both ends of the cable. Connection to cables or lines will be made according to the selected standard with a nominal source impedance of 10 ohms.

4.1. EFT/B Level

This test is performed to the input power lines according to IEC 61000-4-4 Level 3.

Limits (Applied peak voltage)

- Voltage = ±2 kV : for secondary or derived power distribution systems (Level 3)

Pulse Shape

- Impulse of 5 ns (±30 %) rise time, 50 ns pulse width, double exponential

Repetition

- Repetition rate = 5 kHz (±2 kVp-p)
- Burst duration = 15 ms
- Burst period = 300 ms

4.2 Application Points

EFT/B pulses shall be applied between following test points on the Test Specimen and a reference ground plane:

(1) "Line" for AC connections to the power supplies.
(2) "Neutral" for AC connections to the power supplies, and
(3) Ground Cable connected to the chassis.

If there are more than one modules or inputs that are the same type, EFT/B can be applied to only one representative module for each type.

The EFT/B Test procedure will specify the exact locations for application of EFT/B, based on the list of points required above.

5. ACCEPTANCE CRITERIA

During the application of the EFT/B Testing as specified in ERS Section 5.5.5, the Test Specimen Units shall be capable of normal processing of input data and producing output data.

In addition, the application of the specified EFT/B levels shall not damage any module or device, or cause disruption of operation that could result in a loss of safety-related function.

Detailed acceptance criteria are specified in the procedure for this test.

6. RECORDS

(1) Electrical Fast Transient Burst Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 8 ESD TEST PLAN

1. GENERAL

The purpose of this test is to demonstrate the suitability of the Test Specimen Units for qualification as a safety-related device with regard to Electro Static Discharge (ESD) withstand capability. IEC 61000-4-2 testing is performed.

ESD Testing is performed to assure that the Test Specimen withstands the ESD levels given in the ERS, section 5.5.6. The ERS ESD Test levels comply with the levels shown in EPRI TR-107330 Section 4.3.8.

The tests will be performed according to EPRI TR-102323-R1 Appendix B Section 3.5.

ESD Testing should be performed in the same test location as the EMI/RFI, Surge Withstand Capability and EFT/B Tests. If the ESD Testing should be performed in another place, a System Set-up and Check-out Test shall be performed prior to the test.

Environmental conditions are kept at "Normal environmental basic conditions" shown in ERS section 5.5.1.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units

(2) IEC61000-4-2: 1995, "Electrostatic discharge immunity test" Amendment 1 (1998), Amendment 2 (2000)

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. [ ]^{a,c} will provide equipment needed to perform this ESD Testing in accordance with

procedures that are reviewed and approved by Toshiba. [ ]^{a,c} equipment shall be calibrated in accordance with approved procedures.

The test setup information in the ESD Test Procedure indicates the mounting method and interfaces of the Test System.

4. DESCRIPTION OF TEST PROCEDURE

The Test System may be installed in an anechoic chamber during the test; however the chamber may be open. The Test System is operating during test, but sensitive signal simulation, data acquisition, and monitoring equipment is not connected when performing the actual static discharges test. [ ]^{a,c} provides instrumentation for measurement and verification of applied static discharge test levels.

4.1. ESD Test (ERS Section 5.5.6)

This test is performed according to IEC 61000-4-2 Level 4.

Pulse Wave Shape:	Specified as current output from 150 pF storage capacitor through a 330 ohm discharge resistance into a specific load defined in IEC 61000-4-2.
Pulse Rise Time:	Equal or less than 1 ns
Pulse Decay Time:	Approximately 30 ns at 50 % height
Pulse Amplitude:	Specified in terms of charge voltage to simulator. For uncontrolled ambient temperature, pressure, and humidity
Air discharge:	±15kV
Contact discharge:	±8kV
Pulse repetition:	Apply ten simulations for each polarity at each test point while the Test System is operating
Relative Humidity:	Between 30%RH and 60%RH
Test Points:	Front Panel, Handle of Test Specimen, and Cables connected to the Test Specimen Units.
Test Method:	Contact discharge for conducted surface,

Air discharge for insulated surface,
Indirect discharge for front and back panel.

5. ACCEPTANCE CRITERIA

During the application of the ESD Testing as specified in ERS Section 5.5.6, the Test Specimen Units shall be capable of normal processing of input data and producing output data.

In addition, the application of the specified ESD levels shall not damage any module or device, or cause disruption of operation that could result in a loss of safety-related function.

Following ESD Testing, the Test Specimen Units shall be able to perform its safety functions as required in ERS section 4.1.2. Specifically, the Test Specimen shall meet the acceptance criteria specified for the Operability Testing at the end of the testing.

Following the testing, the performance of the Test Specimen during the test shall be compared to the baseline performance (measured during Pre-Qualification testing) to determine if the testing impacted the performance and operability of the Test Specimen.

Detailed acceptance criteria are specified in the procedure for this test.

6. RECORDS

(1) ESD Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 9 CLASS 1E TO NON-1E ISOLATION TEST PLAN

1. GENERAL

The purpose of this test is to demonstrate the suitability of the Test Specimen Units for qualification as a safety-related device with respect to providing electrical isolation capability of Class 1E to Non-1E field connections. ERS Section 5.5.7 requires that isolation testing demonstrate that the isolation features conform to IEEE Std 384 (Reference (2)). The test levels shown in the ERS comply with the level shown in Section 4.6.4 of EPRI TR-107330 and IEEE Std 384-1992. IEEE Std 384-1992 requires as follows:

(1) The isolation device prevents shorts, grounds and open circuits on the Non-1E side from degrading unacceptably the operation of the circuits on the 1E side.
(2) The isolation device prevents application of the maximum credible voltage on the Non-1E side from degrading unacceptably the operation of the circuits on the 1E side.

Class 1E to Non-1E Isolation Testing should be performed in the same test location as the EMI/RFI, Surge Withstand Capability, EFT/B and ESD Tests. If Class 1E to Non-1E Isolation Testing should be performed in another place, a System Set-up and Check-out Test shall be performed prior to the isolation testing.

Environmental conditions are kept at "Normal environmental basic conditions" shown in ERS section 5.5.1.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units
(2) IEEE Std 384-1992, "IEEE Standard Criteria for Independence of Class 1E

Equipment and Circuits"

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. [e]a,c will provide equipment needed to perform this isolation testing in accordance with procedures that are reviewed and approved by Toshiba. [ ]a,c equipment shall be calibrated in accordance with approved procedures.

The test setup information in the Class 1E to Non-1E Isolation Test Procedure indicates the mounting method and interfaces of the Test System.

4. DESCRIPTION OF TEST PROCEDURE

The Test System should be installed in an anechoic chamber during test; however, the chamber may be open. The Test System is operating during test, but sensitive signal simulation, data acquisition, and monitoring equipment is not connected when performing the actual fault test conditions. [ ]a,c provides instrumentation for measurement and verification of applied electrical fault levels.

4.1. Class 1E to Non-1E Isolation Test (ERS section 5.5.7)

Applied Voltage/Ampere:	600 VAC and 250 VDC / 25 ampere
Duration:	30 sec.
Test Points:	A sampling of Class 1E to Non-1E connections; at least one of each type of AO modules

Whenever the Isolation Test may result in damage or destruction of the affected AO module, any damaged or destroyed AO modules shall be replaced with identical spare modules following the test.

5. ACCEPTANCE CRITERIA

During the Isolation Test as specified in ERS Section 5.5.7, the Test Specimen Units shall be capable of normal processing of input data and producing output data.

The isolation test may result in damage or destruction of the AO modules tested. The application of the isolation test voltage shall not damage any other module or device, or cause disruption of operation that could result in a loss of safety-related function.

Detailed acceptance criteria are specified in the procedure for this test.

6. RECORDS

(1) Class 1E to Non-1E Isolation Test Report
(2) Completed Test Procedures and Attachments

APPENDIX 10 PERFORMANCE PROOF TEST PLAN

1. GENERAL

In the Pre-Qualification Test (Appendix 2), the acceptable operation and baseline performance data of the Test Specimen Units are confirmed by conducting the Operability and Prudency Tests. In the Qualification Tests (Appendices 3 to 9), operability and performance of the Test Specimen under and after the simulated severe conditions are confirmed.

At the Performance Proof Test stage, the Operability Test and Prudency Test are performed again simply to confirm that the Test Specimen provides the required operability and performance even after being exposed to aging and stress factors of the complete qualification test series.

The Performance Proof Test will be carried out as follows:

(1) **System Set-up and Check-out Test (Test Procedure: FPG-TPRC-C51-1001).** The purpose of this test is to verify proper assembly, integration and operation of the assembled Test System for the Performance Proof Test. This test confirms the proper connection and operation of whole Test System including monitoring instruments, power supplies, signal simulators, and communication links.

(2) **Operability Test (Test Procedure: FPG-TPRC-C51-1009).** The purpose of this test is a demonstration of acceptable system operability at the end of qualification testing.

(3) **Prudency Test (Test Procedure: FPG-TPRC-C51-1010).** The purpose of this test is a demonstration of acceptable system performance at the end of qualification testing.

Environmental conditions for the Performance Proof Tests are kept at the "Normal

environmental basic conditions" shown in ERS section 5.5.1.

Note: Whenever the Isolation Test may result in damage or destruction of the affected AO module, any damaged or destroyed AO modules shall be replaced with identical spare modules following the Test.

2. REFERENCES

(1) FPG-RQS-C51-0001
Equipment Requirement Specification for FPGA based Units

3. TEST EQUIPMENT

Test Equipment provided by Toshiba is described in Appendix 1 and MTP section 6.3. No[ ]^{a,c} equipment is needed to perform this.

The test setup information in the Performance Proof Test Procedure indicates the mounting method and interfaces of the Test System.

4. ACCEPTANCE CRITERIA

For the System Set-up and Check-out Testing, acceptance criteria include verifying that the Test System is correctly configured in accordance with the applicable drawings.

ERS Section 7.2 provides detailed acceptance criteria for the Operability and Prudency Testing performed during the Performance Proof Test. In general, the ERS acceptance criteria are as follows:

- For Operability Testing: Acceptance criteria are provided for accuracy,

response time, discrete input and output operability, response to loss of power, and response to power interruption.

- For Prudency Test: Acceptance criteria are provided for response time for the burst of events test and response to the fault simulation test.

Following the testing, the performance of the Test Specimen during these tests shall be compared to the baseline performance (measured during Pre-Qualification Testing) to determine if the testing impacted the performance and operability of the Test Specimen.

Detailed acceptance criteria are specified in the Operability Test Procedure and the Prudency Test Procedure.

5. RECORDS

(1) Performance Proof Test Report
(2) Completed Test Procedures and Attachments

APPENDIX A CROSS REFERENCE TABLE with ERS and PQAM

This appendix provides the cross Reference table between Master Test Plan and ERS or PQAM.

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	5.1.3.1. Response Time Requirements	Qualification testing provides reasonable assurance that the total system response time requirement (from the ERS) is satisfied.	3
ERS	5.1.4. Drift and Accuracy Requirements	Qualification testing provides reasonable assurance that the linearity requirement (from the EPRI TR-107330) is satisfied.	3

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	5.1.5. Instrument Modes	Qualification testing provides reasonable assurance that the mode function requirement (from the ERS) is satisfied.	3
ERS	5.2.4.6. Termination Requirements	Qualification testing provides reasonable assurance that the termination requirements are met.	3
ERS	5.4. Design Life	Qualifications testing with qualification analyses provide reasonable assurance that the aging requirements are met.	7

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	5.5.1. Environmental Requirements	Qualification testing provides reasonable assurance that the environmental requirements are met.	Appendix 3
ERS	5.5.2. Seismic	Qualification testing provides reasonable assurance that the seismic requirements are met.	Appendix 4
ERS	5.5.3. EMI/RFI requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 5
ERS	5.5.4. Surge Withstand Capability Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 6

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	5.5.5. ETF/B Withstand Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 7
ERS	5.5.6. ESD withstand requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 8
ERS	5.5.7. Isolation requirement	Procurement for CGI ensures that vendor provides items that NED has selected based on the requirements. Qualification testing provides reasonable assurance that the requirements are met.	Appendix 9
ERS	5.5.8. Power Supply	Qualification testing provides reasonable assurance that the requirements are met.	Appendix3, Appendix 4

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	5.6. Classification	Qualification testing shall be performed in accordance with 10CFR50 Appendix B QA Program.	6.5
ERS	7.2.2 Operability Test Requirements	Qualification testing provides reasonable assurance that the requirements are met.	4
ERS	7.2.3 Prudency Test Requirements	Qualification testing provides reasonable assurance that the requirements are met.	4
ERS	7.2.4 Operability and Prudency Tests Applicability	Qualification testing provides reasonable assurance that the requirements are met.	4
ERS	7.3.1 Test Specimen Requirements	Qualification testing shall provide reasonable assurance that testing will meet the ERS requirements.	Appendix 1

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	7.3.1.3. Test Support Equipment Requirements	Control of Test Equipment shall be part of the qualification testing scope.	6.4
ERS	7.3.2 Qualification Tests and Analysis requirements	Qualification testing shall provide reasonable assurance that testing will meet the ERS requirements.	4
ERS	7.3.2.1. Aging Requirement	Qualification testing provides reasonable assurance that the requirements are met.	4
ERS	7.3.2.2. EMI/RFI Test Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 5
ERS	7.3.2.3. EMI/RFI Test Mounting Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 5
ERS	7.3.2.4. Environmental Test Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 3
ERS	7.3.2.4.1. Environmental Test Mounting Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 3

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	7.3.2.5. Seismic Test Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 4
ERS	7.3.2.5.1. Seismic Test Mounting Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 4
ERS	7.3.2.6. Seismic Test Measurement Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 4
ERS	7.3.2.6.1. Seismic Test Performance Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 4
ERS	7.3.2.6.2. Seismic Test Spectrum Analysis Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 4
ERS	7.3.2.7. Surge Withstand Capability Test Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 6
ERS	7.3.2.8. Class 1E to Non-1E Isolation Test Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 9
ERS	7.3.2.9. EFT/B Test Requirement	Qualification testing provides reasonable assurance that the requirements are met. Qualification testing provides reasonable assurance that the requirements are met.	Appendix 7

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	7.3.2.10 ESD Test Requirement	Qualification testing provides reasonable assurance that the requirements are met.	Appendix 8
ERS	7.3.2.11. Power Quality Tolerance Requirement	Qualification testing provides reasonable assurance that the requirements are met.	4
ERS	7.3.3. Requirements for Compliance to Specifications	Qualification testing provides reasonable assurance that the requirements are met.	4
ERS	8.1. Packaging Requirements	Qualification testing requirements provide reasonable assurance that the packaging by [ ]a,c will be in accordance with these requirements.	10
ERS	8.2. Shipping Requirements	Qualification testing requirements provide reasonable assurance that shipping by NED to and from [ ]a,c and by [ ]a,c within the US, will be in accordance with these requirements.	10

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	8.3. Storage Requirements	Qualification testing requirements provide reasonable assurance that the[ ]^{a,c}storage will be in accordance with these requirements.	10
ERS	9.2.1 Programmatic Documentation Requirements D.	Audits will be performed during CGI, CGS, testing (and to approve[ ]^{a,c}, FPGA development (per the SQAP), and of third parties. These activities provide reasonable assurance that the audit requirements will be satisfied.	6.5
ERS	9.2.9. System Software/Hardware Configuration Document	Qualification testing provides reasonable assurance that the requirements are met.	1.3, 1.4

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
ERS	9.2.10. System Setup/Calibration/Check-out Procedure	Qualification testing provides reasonable assurance that the requirements are met.	6.5
ERS	9.2.11. System Test Documentation	Qualification testing provides reasonable assurance that the requirements are met.	11
PQAM	13.3 Qualification Testing	NED will perform the qualification testing, which provides reasonable assurance that the requirement for test QA and witnessing are met.	6.5
PQAM	16 Nonconforming Materials, Parts or Components	CG procurement requirements for problem reporting provide reasonable assurance that problem reporting requirements are met. Work under the NED QA program provides reasonable assurance that problem reporting requirements are met.	9

Document	SECTION of ERS or PQAM	Requirements Summary for Qualification Test	MTP Section
PQAM	19 Reviews, Audits and Surveillance	This requirement is met by the following activities: -- CG survey of Fuchu Complex -- App B Audit of[ ]^{a,c} -- In-process audits of Fuchu Complex (Job Order will state requirement that NQAD shall have access to Fuchu Complex for audits)	6.5

APPENDIX B CROSS REFERENCE TABLE (EMI/RFI, Surge Withstand Capability, and EFT/B TEST)

Low Frequency Conducted Susceptibility(Power)	5	MIL-STD 461E CS101	30(120)Hz-150kHz	4.1.1	Conducted Susceptibility	4.3.7 B	B 3.2	30Hz-50kHZ	MIL-STD 461D CS101
High Frequency Conducted Susceptibility(Power)	5	MIL-STD 461E CS114	10kHz-30MHz	4.1.2				50kHz-400MHz	MIL-STD 461D CS114
High Frequency Conducted Susceptibility(Signal)	5	MIL-STD 461E CS114	10kHz-30MHz	4.2					
	5	MIL-STD 461E CS115	impulse excitation	4.2	-	-	-	-	-
	5	MIL-STD 461E CS116	damped sinusoidal transients, 10kHz-100MHz	4.2	-	-	-	-	-
Low Frequency Radiated Susceptibility	5	MIL-STD 461E RS101	30Hz-100kHz	4.3.1	-	-	-	-	-
High-Frequency Radiated Susceptibility	5	MIL-STD 461E RS103	30MHz-10GHz	4.3.2, 6.	Radiatied Susceptibility	4.3.7 A	B 3.1	10kHz-1GHz	MIL-STD 461D RS103
Low Frequency Conducted Emissions	5	MIL-STD 461E CE101	30(120)Hz-10kHz	3.1	Conducted Emission	4.3.7D	7	30Hz-50kHz	MIL-STD 461D CE101
High-Frequency Conducted Emissions	5	MIL-STD 461E CE102	10kHz-2MHz	3.2				50kHz-400MHz	MIL-STD 461D CE102
Low-Frequency Radiated Emissions	5	MIL-STD 461E RE101	30Hz-100kHz	3.3	Radiated Emission	4.3.7C		30Hz-100kHz	MIL-STD 461D RE101
High-Frequency Radiated Emissions	5	MIL-STD 461E RE102	2MHz-1GHz	3.4				10kHz-1GHz	MIL-STD 461D RE102
SURGE(Ring Wave, Power)	6	IEC 61000-4-	2kV/4kV	5.	Surge Wi hstand Capability	4.6.2	B 3.3	3kV	MIL-STD 461D CS116, IEEE C62.41-1991
SURGE(Combination Wave, Power)	6	IEC61000-4-5	2kV/4kV	5.					
EFT/B (Power)	7	IEC61000-4-4	2kV/4kV	5.			B 3.4	3kV	IEC 801-4